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POPULAR ELECTRONICS

JUNE 1968

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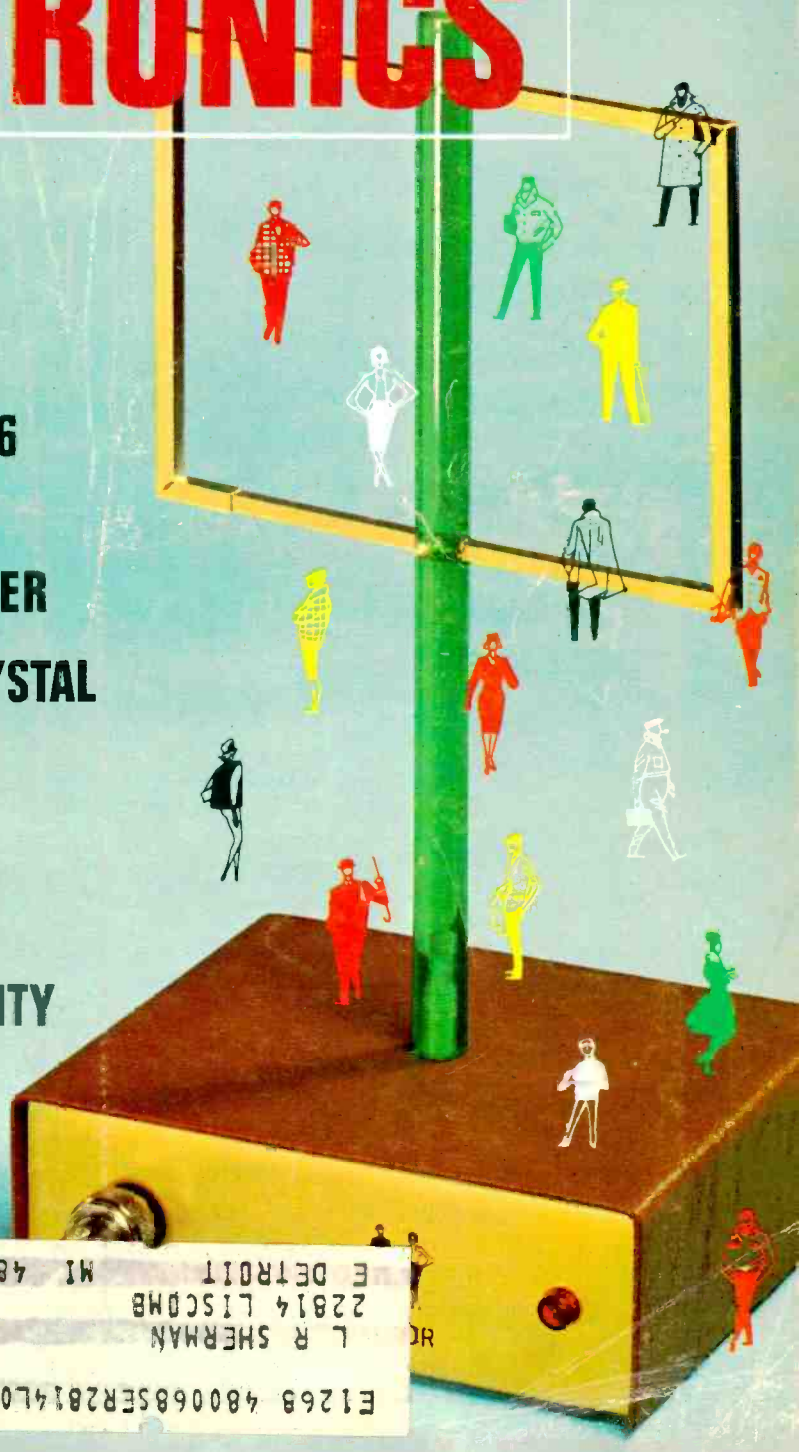

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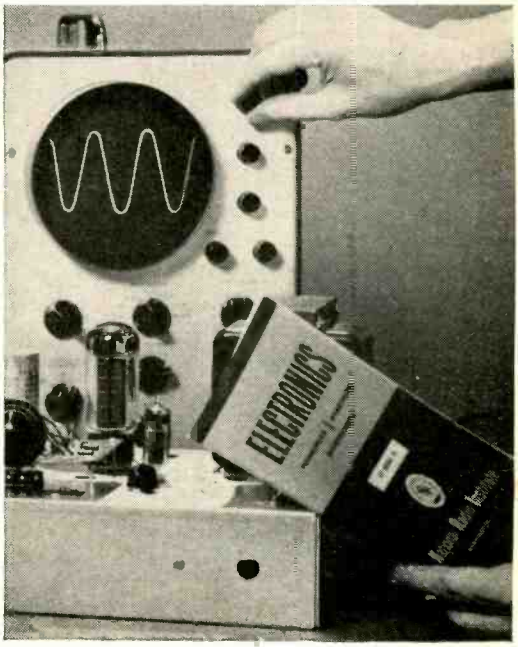

POPULAR ELECTRONICS

VOLUME 28 NUMBER 6 **JUNE, 1968**

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

SPECIAL FEATURE

SPECIAL CONSTRUCTION PROJECT

FEATURE ARTICLES

DEPARTMENTS

POPULAR ELECTRONICS is indexed in the Readers' Guide to Periodical Literature

This month's cover photo by Conrad Studios

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These are the quality features to look for if you want a superb automatic turntable for your hi-fi system.

A vital determinant of the quality of an automatic turntable is the tone arm system. Here are some of the tone arm and related features that make the BSR McDonald automatic turntables the sophisticated units they are.

A resiliently mounted coarse and fine Vernier Adjustable Counterweight delicately counterbalances the tone arm assuring sensitive and accurate tracking.

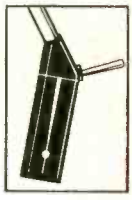
Micrometer Stylus Pressure Adjustment permits ⅓ gram settings all the way from 0 to 6 grams. This important part of the tone arm assures perfect stylus pressure in accordance with cartridge specifications.

A much appreciated feature built into all BSR McDonald automatic turntables is the Cueing and Pause Control Lever. It permits pausing at any listening point and then gently permits the tone arm to be lowered into the very same groove. Positioning of the stylus anywhere on the record is accomplished without fear of damaging the record or the cartridge.

To achieve the ultimate in performance, BSR McDonald has brought to perfection the Anti-Skate Control. This adjustable dynamic control applies a continuously corrected degree of compensation as required for all groove diameters. It neutralizes inward skating force and eliminates distortion caused by unequal side wall pressure on the stylus. All of the BSR McDonald automatic turntables incorporate anti-skate.

After the last record has played on any of the three BSR McDonald automatic turntables, the tone arm automatically returns to the Locking Rest. In conjunction with this action, the On-Off-Reject lever automatically shifts into the Off position which securely locks the tone arm in its cradle to protect it from accidental drops and resulting stylus damage.

All BSR McDonald automatic turntables have a Clip-In Cartridge Head. This lightweight tone arm head, with finger lift and clip-in cartridge holder, provides universal mounting and quick change facility. It can accommodate practically every contemporary cartridge currently on the market.



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Contributing Editors

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Advertising Sales Manager

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Advertising Service Manager

ZIFF-DAVIS PUBLISHING COMPANY

Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212 679-7200
Eastern Advertising Manager, RICHARD J. HALPERN

Midwestern Office
307 North Michigan Avenue, Chicago, Illinois 60601
312 726-0892
Midwestern Advertising Manager, JAMES WEAKLEY
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Western Office
9025 Wilshire Boulevard, Beverly Hills, California 90211
213 CRestview 4-0265; BRadshaw 2-1161
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Japan: James Yagi
Ishikawa Mansion
#4, Sakuragaoka
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Learn I.C.'s...Build this new RCA Audio Amplifier Kit

RCA's new Integrated Circuit Experimenter's Kit, KD2112, is the first of its kind. You get a "short course" in integrated circuits, and you can build a 500-milliwatt audio amplifier or a variable-tone audio oscillator.

The heart of this new "all-parts-included kit" is an RCA linear integrated circuit—a multipurpose wide-band audio amplifier—containing the equivalent of 7 transistors, 11 resistors, and 3 diodes.

Each kit comes with a 20-page manual which gives complete step-by-step kit construction details. An extra I.C. "chip," with case removed, is also supplied so that its circuitry can be examined.

RCA's new Integrated Circuit Experimenter's Kit KD2112 is available from your RCA Distributor. Ask him for it, and learn more about I.C.'s.

RCA Electronic Components, Harrison, N. J. 07029

RCA

letters

FROM OUR READERS

HOW TO ADD MORE DCU'S

The Decimal Counting Unit ("Low-Cost Counting Unit," February, 1968) is great! But please tell me how to add more decades (the article stated that the power supply would support only three). The "Ultra-Fast Electronic Stopwatch" (March, 1968), in particular, could make use of extra decades.

DAVID R. BLOCK
St. Paul, Minn.

Bear in mind that each DCU draws about 400 mA. Therefore, if you add more counters, the power transformer must be replaced with a unit capable of delivering the required current (plus about 300 mA to allow for timer circuit drain). Consequently, the rectifier must also be replaced with a unit capable of handling the increase in current. Then you connect the "carry" and "count" terminals on the individual boards as shown on page 31 of the "Stopwatch" article.

DIGITAL READOUT "REAL TIME" CLOCK

When can we expect a "real time" clock using the "Digital Counting Unit" as the basic building block?

HAL SHURNICK
New York, N.Y.

Although we're getting a little ahead of ourselves on this one, a "real time" clock is now under development. We don't know at this point exactly when it will appear in print but, in the meantime, other DCU projects will be coming your way.

THEREMAIN REVISITED

I had a problem with my theremin ("Music A La Theremin," November, 1967) which was similar to the one described by J.C. Demunter in your February, 1968, "Letters from Our Readers" column. Upon investigating, I found that I had diode *D1* connected backwards. After I corrected the error, tuning became very easy, and I am now quite satisfied with my theremin. I also found that the leads of coil *L2* were prone to touching the coil's mounting bracket—so I took special care to keep all leads in the clear.

CLAYTON RUTH

After some experimenting with my theremin I discovered that coil *L2* produces many groups of audio signals and that the correct signal to tune is the one that is loudest. This can be accomplished by adusting *L2* (some

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CIRCLE NO. 18 ON READER SERVICE PAGE

LETTERS

(*Continued from page 8*)

manipulation of *L1* might also be necessary) until a point is reached where the background noise is blanked out by a high-frequency pitch that moves on down to a low-frequency pitch and stops, then begins again. Tune to the point where the low-frequency pitch just about starts up again. Finally, tune coil *L4* for a loud signal, stopping immediately after the signal fades out.

Mr. Demunter probably had his theremin tuned to one of several points where the pitch and volume oscillators are coupled together through the mutual inductance of the coils. Although this will produce a very pure tone, the volume plate controls the pitch, and there is very little output power. Retuning the theremin as described above should solve his problem—it solved mine.

KEN HAVEN
Wilmington, Del.

Believe me, if it were not for the step-by-step instructions given by your magazine, the instructions I received with my theremin kit would have been entirely inadequate. Evidently, Southwest Technical Products assumed that the kit builder already had the information supplied in your magazine. As for the theremin itself, it is apparent that the combination of circuits for *Q5* and *Q6* are efficient to a certain point in reducing the volume to zero. On the other hand, there's volume galore when approaching the volume antenna. In fact, I find that the unit has sufficient gain to drive an earphone—so I can practice to my heart's content without driving anyone else to distraction.

LAWRENCE F. CACCOMO
Omaha, Nebr.

There are probably many readers in addition to Mr. Demunter who will benefit by the suggestions Clay and Ken have given here. All we can say to you, Larry, is good work, and enjoy your instrument.

+11001 INSTEAD OF +11011

With regard to the Binary Adder article ("Demonstrating Binary Computation With The Binary Adder," April, 1968), in Step B of the first example under "How System Works" on page 92, minus seven should be +11001 and NOT +11011 as shown.

L. H. WELLS, JR.
Los Angeles, Calif.

Oops! Good catch. We hope that none of our readers were bothered by this typographical error.

DIFFICULT-TO-GET PARTS

With regard to your answer to M. M. Behrens' letter ("Letters From Our Readers," January, 1968), if readers are unable to obtain parts or substitutes, a construction article is of no value—no matter how much time the author spends on the article. I subscribed

There has never been a better color-bar generator than the RCA WR-64B...

until now!

The RCA WR-502A CHRO-BAR color-bar generator is all solid-state, battery operated... Provides color bars, dots, crosshatch, vertical lines, horizontal lines, blank raster.. has rock-solid stability. It's the greatest yet. The CHRO-BAR. $168.00*.

RCA Electronic Components, Harrison, N.J.

*Optional Distributor resale price. Prices may be slightly higher in Alaska, Hawaii and the West.

RCA

CIRCLE NO. 32 ON READER SERVICE PAGE

LETTERS (*Continued from page* 10)

to POPULAR ELECTRONICS strictly for the build-them-yourself projects. Now, after spending a lot of time and money for one of the projects that appeared in your magazine, I find that our local Motorola Distributor never heard of the particular transistors used in the project, nor could I obtain any help from Allied Radio or General Electric.

S. M. CHRISTIE
Decatur, Ga.

We agree that a construction project is no good if you can't get the parts specified. However, at the time every project goes into print, the parts specified in the Parts Lists ARE available. Agreed, some parts are not available from every mail order supply house, and this is often the case with semiconductors—especially the newest ones. Semiconductor technology changes day by day.

However, although not all distributors carry a full line of the 5000-plus semiconductors now on the market, you can be sure that other distributors have the parts you need. If you're looking for a particular part, and your local distributor doesn't have it in stock, ask him for that manufacturer's "List of Authorized Distributors."

You did not say in your letter what project you wanted to build or exactly what part you wanted to buy. With this information at hand, we might have been able to be of more help to you.

IMPROVED NEW TRANSISTOR TESTER

Quite by accident, I came up with an improvement on Don Lancaster's "NGW Transistor Tester" circuit (December, 1967). The accident was that I was all out of 10-mA meter movements and had to substitute a 1-mA unit with an appropriate shunt resistor that would still allow the meter to measure up to 10 mA of current. Then, the first time I used the transistor tester, I noted that most leakage values were less than 1 mA, with the result that the meter pointer barely moved away from 0 with the shunt in the circuit. So, I decided to install a normally-closed, momentary-action push-button switch between one terminal on the meter and the shunt resistor. Now I can measure small leakage currents with relative ease.

To use the modified transistor tester properly, you set the tester up exactly as described in the article, but when making leakage tests, you also depress the new switch. In all other tests, the switch should remain untouched to prevent burning open the meter movement.

BEVERLY R. ROGEN
Bronx, N.Y.

This sounds like a good modification. It should help to relieve eyestrain when you're using the "NGW Transistor Tester" for making leakage tests. The value of the shunt resistor, of course, will depend on the resistance of the meter movement used. —30—

Check these CHRO-BAR color bar generator features... on the fingers of one hand

...if you count two to a finger and one for the thumb...

1 rock solid stability 2 portability (battery operated) 3 all solid-state (silicon transistors) 4 rugged (cast aluminum case and brushed aluminum panel) 5 crystal control (4 crystals) 6 sound carrier provided 7 provision for spare battery (switch selection, battery meter) 8 gun killer (switches and leads) 9 all new circuit design. It's the greatest yet. The CHRO-BAR. $168.00*. RCA Electronic Components, Harrison, N.J.

*Optional Distributor resale price. Prices may be slightly higher in Alaska, Hawaii and the West.

RCA

CIRCLE NO. 33 ON READER SERVICE PAGE

Squires Sanders

OUT TO LAUNCH THE SS FLEET, that is.

NOW HEAR THIS... the all new Squires-Sanders fleet of top performance CB transceivers is now being launched. Shiver-me-timbers, you've never seen such an array of fine CB equipment this side of Davy Jones' locker. This is the ALL SOLID STATE fleet – with the best in performance, features, and styling at prices to suit every requirement or desire. Top deck is the luxurious ADMIRAL 23 channel base station . . . then the COMMODORE mobile with the patented Pulse Eliminator. On the bridge the SKIPPER is blasting out on all 23 and in the wheelhouse is the terrific 2 channel 3 watt YEOMAN portable. The SS all solid state fleet is for you . . . from port to portable! You are invited to the launching – Ask your distributor for details and write today for full color literature.

The ADMIRAL: luxurious new all solid state 23 channel CB base station • highly sensitive receiver • Pulse Eliminator • 5 watt transmitter • Speech Compression • +2 mike • dual antenna • HiLo sensitivity • Public Address • Delta Tune • adjustable squelch • ON-THE-AIR light • illuminated S meter • digital panel clock • earphone jack • regulated AC power supply

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The SKIPPER: new low priced solid state 23 channel CB transceiver • superb dual conversion FET/IC no-overload receiver • advanced design noise limiting • illuminated S meter and channel • solid state T/R switching • Speech Clipping • 100% modulation • P.T.T. mike • Local/Distant sensitivity • external speaker jack • Public Address • Exclusive "All Position" Safety Breakaway Mount • only 3 lbs.: 1¾ x 6 x 8"

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The COMMODORE: 23 channel, solid state mobile CB transceiver • Ultra sensitive ½ μv double conversion receiver • crystal filter, 7 KC selectivity • adjustable squelch • flat AGC • Pulse Eliminator removes ignition noise • 3 watts audio • 5 watts input • 100% modulation • PTT mike • 26 transistors, 7 diodes • 4 lbs, 3½ x 7 x 8

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The YEOMAN: fine, powerful portable CB transceiver • 2 channels, equipped with ch 7 • Sensitivity ½ μv • AGC • Adjustable Squelch • Noise Limiter • 3 watts input, 2½ watts output • Operates on 8 pen-lite batteries • Battery/RF Power • Call signal • 54" whip antenna • Earphone • under 2 lbs 3 x 8 x 1¾

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2. Cut out the coupon and mail it to the address indicated below.

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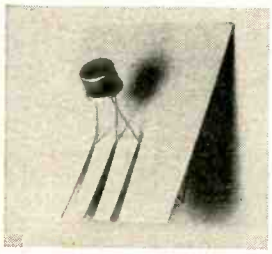
6

PARTS/METHODS/IDEAS/GADGETS/DEVICES

tips & techniques

NO-COST HEAT SINK PREVENTS HEAT DAMAGE

You can use a heat sink made from scrap copper or aluminum (see photo) to protect transistors and diodes from heat damage when soldering them to printed circuit boards. Taper the slots to fit the type of transistor being mounted (the prongs of the heat sink should clamp onto all three transistor leads simultaneously). However, if you design your own printed circuit boards and take care to maintain all transistor and diode lead hole centers reasonably the same, two or three different such heat sinks will generally suffice for most components—other than those in TO-3 and TO-36 cases. Use very thin sheet copper or aluminum for close-to-the-board mounting. And you'll have to mount the solid-state parts on the board first.



—Roland J. Tauer

SPRAY-PAINT CAN CAPS KEEP YOUR WORKBENCH NEAT

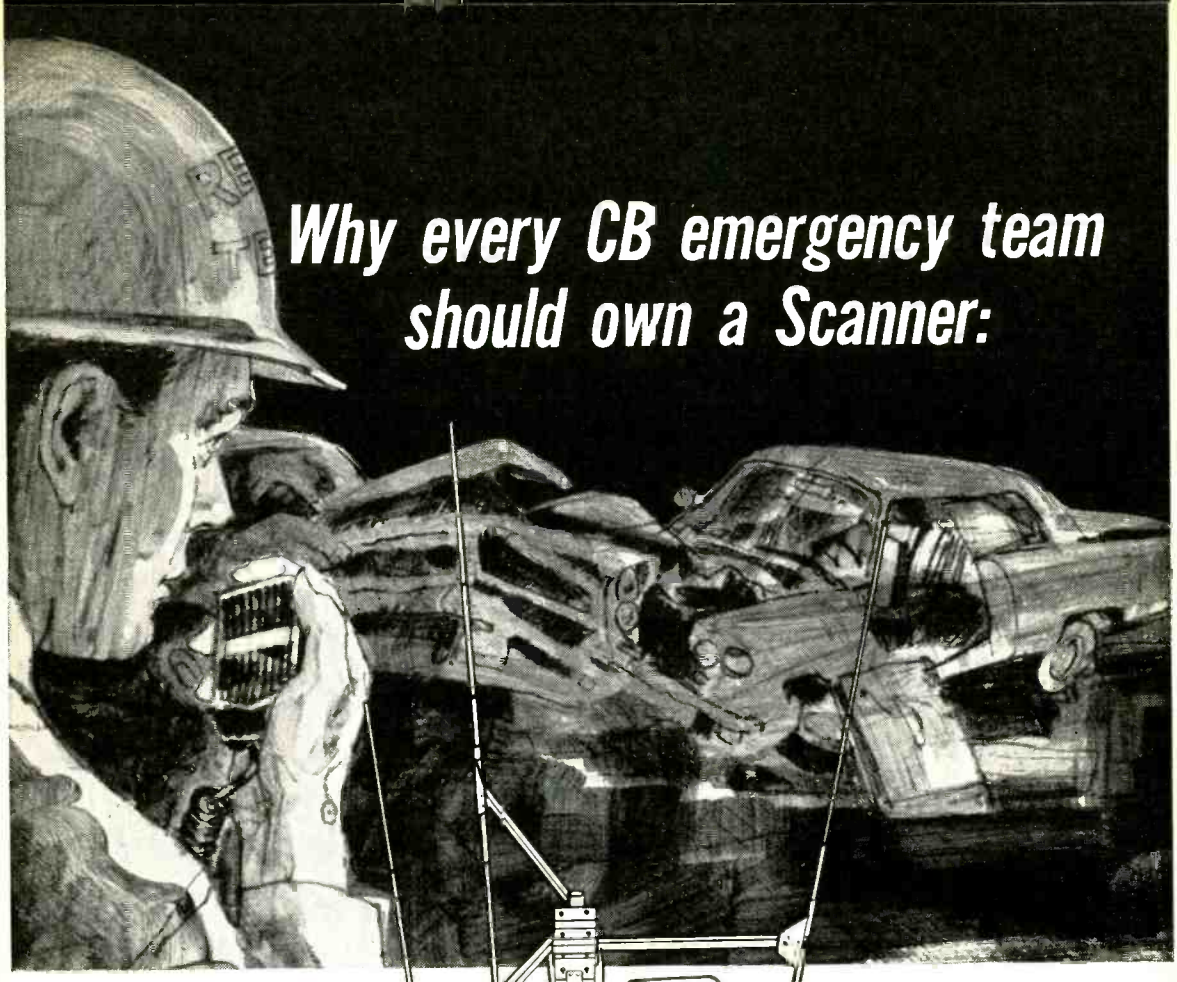
Neatness counts on your workbench when you are building a project or servicing equipment. To help keep things orderly and make locating small parts like nuts, bolts, washers, resistors and disc capacitors easy, save the caps from empty spray-paint cans and use them as containers as shown in the photo. You can use each cap as is, or bolt several of them to a piece of wood to hold different sizes and types of parts. *—James E. Arconati*

PREVENT WARPED CABINET FROM CAUSING AUDIO SIGNAL DISTORTION

In some table radios that have plastic cabinets, the speakers are fastened to the inside

(*Continued on page* 80)

Why every CB emergency team should own a Scanner:



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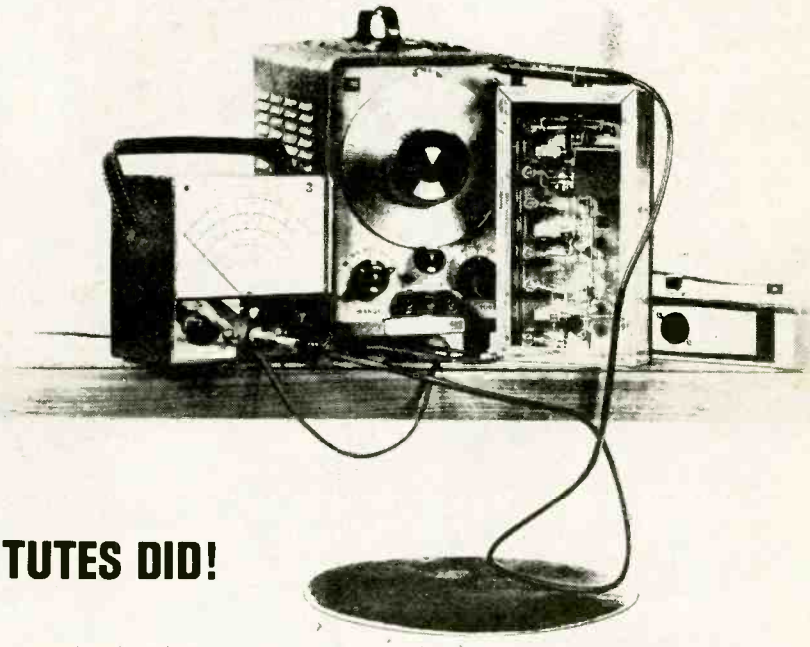
CIRCLE NO. 2 ON READER SERVICE PAGE

SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



RCA INSTITUTES DID!

Here is a whole new approach to learning electronics at home! RCA Institutes, one of the nations' largest schools devoted to electronics, has developed a faster, easier way for you to gain the skills and the knowledge you need for the career of your choice. Here for the first time, is a student-proved, scientifically designed way to learn. If you have had any doubts in the past about home training in electronics —if you have hesitated because you thought you might not be able to keep up—or that electronics was too complicated to learn— here is your answer! Read how RCA Institutes has revolutionized its entire home training ideas!

NEW CAREER PROGRAMS BEGIN WITH "AUTOTEXT" INSTRUCTION METHOD!

Start to learn the field of your choice immediately!

No previous training or experience in electronics needed!

With this new revolutionized method of home training you pick the career of your choice—*and RCA Institutes trains you for it.* RCA's Career Programs assure you that everything you learn will help you go directly to the field that you have chosen! No wasted time learning things you'll never use on the job! The Career Program you choose is especially designed to get you into that career in the fastest, easiest possible way!

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Automatic Controls. Prepares you to be an Automatic Controls Electronics Technician; Industrial Laboratory Technician; Maintenance Technician; Field Engineer.

Digital Techniques. For a career as a Digital Techniques Electronics Technician; Industrial Electronics Technician; Industrial Laboratory Technician.

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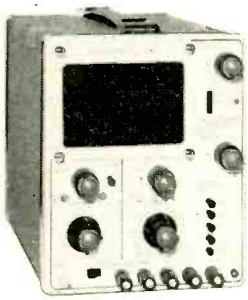
NEW PRODUCTS

Additional information on products covered in this section is available from the manufacturers. Each new product is identified by a code number. To obtain further details on any of them, simply fill in and mail the coupon on page 15.

SOLID-STATE OSCILLOSCOPE

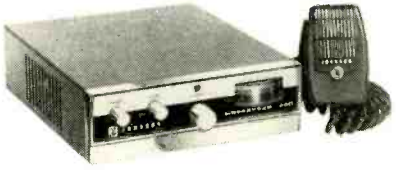
The Type S54 d.c.-to-10-MHz solid-state oscilloscope announced by *Tektronix, Inc.*, is the first addition to its newly acquired low-priced "Telequipment" oscilloscope line designed and manufactured in England. Triggered sweep is one of the most important features of the S54, and calibrated vertical voltage and horizontal time are accurate within 5%. The S54 has a 6-cm. x 10-cm. rectangular CRT, P31 phosphor, and 4-kV accelerating potential. Dimensions are 9″ x 7″ x 16″. (It is also available in a rackmount configuration 5″ high by 19″ wide, as the RS54.) There is a manufacturer's warranty of one year against defective materials and workmanship.



Circle No. 75 on Reader Service Page 15

23-CHANNEL CB TRANSCEIVER

Mobile, base, or portable use is possible with the new 23-channel CB transceiver announced by *E. F. Johnson*. Called the "Messenger 320," the unit is solid state throughout (23 transistors and 15 diodes), and measures 2½″ high by 8″ wide by 9″ deep. The double-conversion superhet receiver has a sensitivity of 0.5 μV for a 10-dB signal-to-noise ratio,



while the transmitter section has a full 5-watt d.c. input. Built-in speech compression provides more audio for greater range without distortion or splatter. The "Messenger 320" is supplied with a mobile mounting bracket. Accessories include a.c. and portable power supplies and a Tone Alert selective calling system.

Circle No. 76 on Reader Service Page 15

FM-AM-FM STEREO TUNER

Features of the *Olson* Model RA-997 FM-AM-FM-stereo tuner include a vertical tuning meter to assure accurate tuning and a stereo indicator light for ease in locating multiplex signals. The tuning range is 88 to 108 MHz on

FM, 535 to 1600 kHz on AM. Sensitivity is 2 μV for 20 dB quieting, and multiplex separation is 30 dB. The oiled walnut finished wood cabinet, with brushed aluminum panel and knobs, is suitable for stacking on top of an amplifier cabinet. Size: 11½″ wide by 4″ high by 8¾″ deep.

Circle No. 77 on Reader Service Page 15

"POLICE AUTO ALARM"

One simple hookup to your car horn, and the inexpensive "Police Auto Alarm" announced by *J. Ross* will protect your car against both thieves and vandals. When you lock your car, you set the alarm switch (attached under your bumper, on the dash or floor board, out of sight) to "on." Any disturbance thereafter to the doors, windows, antenna, trunk, hub caps, etc., will transfer a vibration to the alarm which sets off an intermittent blast from your horn, lasting about 15 seconds. When the tampering stops, the alarm silences itself automatically. Should tampering begin again, the horn resumes its blasting. No batteries are required, and the alarm carries a 10-year guarantee!

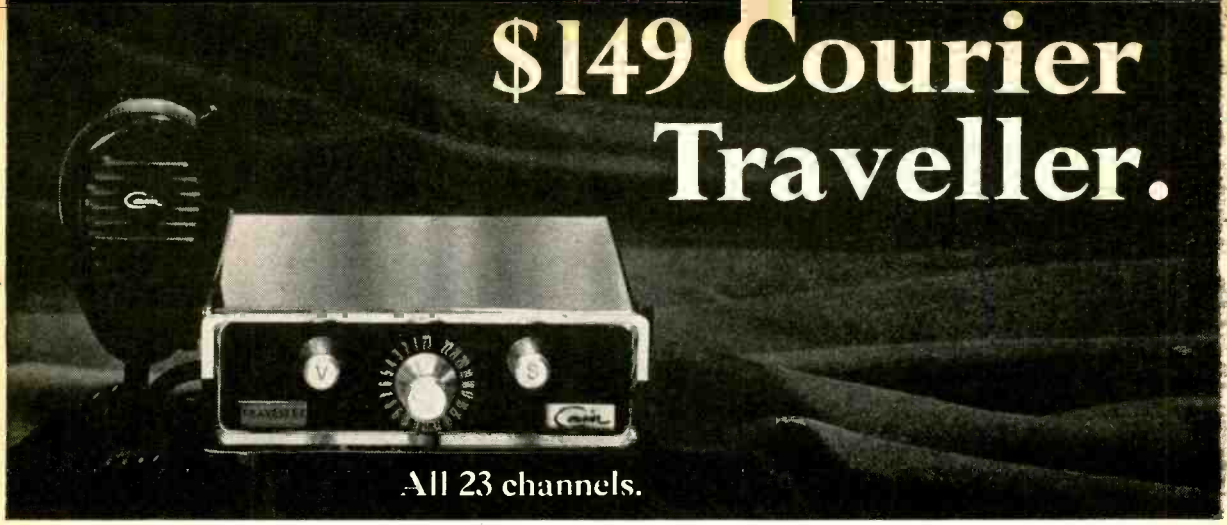
Circle No. 78 on Reader Service Page 15

STEREO CASSETTE DECKS

Two stereo cassette decks have been announced by *North American Philips*: the Norelco "2500," the first stereo cassette playback-only unit; and the "Continental 450A," a stereo recorder/player. The "2500" has push-button controls for on-off and cassette-eject operations and a single selector switch for re-wind, play, stop, and fast forward functions. A heavy-duty clear acrylic dust cover

CIRCLE NO. 12 ON READER SERVICE PAGE→

$149 Courier Traveller.



A product of small thinking.

We put everything into the new Courier Traveller to make it the industry's smallest 23-channel CB transceiver. And the smallest thing of all is its price—$149. Every feature you'd look for to assure total performance—honed down into a compact 5¾" W x 6¼" D x 1⅞" H. Start with silicon-transistors throughout. Exclusive incoming signal indicator, which lights up automatically when receiving S-6 or better signal—keeps your eyes on the road. Super efficient transmitter designed to help pierce "skip." Add illuminated channel selector, auxiliary speaker jack, modulation indicator, and single-knob tuning. Plus exclusive Courier "Safety Circuit" to protect against mismatched antenna, incorrect polarity, and overload. All packed into that remarkably small chassis that fits so conveniently into any auto.

Sorry. There's nothing small about Traveller's guarantee. It's so trouble-free, we had to guarantee it for 10 full years.

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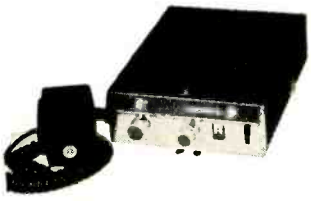
protects the cassette assembly. The more expensive "Continental 450A" has volume, tone, balance, and record level controls, and keyboard push buttons. The latter also boasts a digital counter with automatic zero re-set and a vu meter. Both units come in attractive cabinets.

Circle No. 79 on Reader Service Page 15

SOLID-STATE CB TRANSCEIVER

Streamlined controls for easier operation are featured in *Amphenol*'s Model 777 solid-state CB transceiver. Designed with frequency-synthesizing circuitry for full 23-channel operation, both transmitter and receiver are always "locked-in" on frequency. An illuminated and magnified channel selector switch permits simultaneous dialing of any single transmit and receive channel selected. Volume, on-off, and adjustable squelch are combined in a single front panel control, while primary TR switching is accomplished by a push-to-talk button on the microphone. The Model 777 is packaged in a rugged 6½" x 2" x 10" low-profile case. It can be dash-mounted or placed on an optional pedestal-mount power supply for use in home or office.



Circle No. 80 on Reader Service Page 15

ELLIPTICAL MAGNETIC CARTRIDGE

Major features of the new ADC 10/E-Mark II magnetic cartridge developed by *Audio Dynamics Corporation* are increased resiliency, greater stylus deflection, and a capacity for absorbing shock that makes the cartridge virtually indestructible when used under proper conditions. The broadening of the tracking force range will permit a greater number of people to benefit from the induced magnet principle employed. Originally rated at ½ to 1 gram, the new cartridge will now track at up to 1½ grams; the additional half gram encompasses most systems currently in use. Like the 10/E, the Mark II combines infinitesimally small stylus tip mass with high compliance.

Circle No. 81 on Reader Service Page 15

ALUMINUM CABINETS

Attractive as well as functional, the new line of cowl and standard type aluminum cabinets announced by *Houle Mfg. Co., Inc.*, is available in many sizes. Each cabinet is composed of a chassis, front and rear panels, and a one-piece top cover. The front and rear panels are interchangeable (one is plain aluminum, the other perforated aluminum), while the top cover can be either leather grain aluminum or perforated aluminum. The perforated pieces provide for speaker venting and heat dissipation.

Circle No. 82 on Reader Service Page 15

STEREO AMPLIFIER

How small is a cigar box? *Kenwood*'s KA-2000 stereo amplifier is said to be smaller (10¼" x 4⅛" x 9⅜"), yet will deliver 40 watts, IHF Standard 4 ohms, and 35 watts, IHF Standard 8 ohms, with 13 watts continuous power per channel (0.5% T.H.D.). Frequency response is 20-50,000 Hz ± 1 dB. Built-in circuits include a tape monitor switch, loudness control, and bass and treble control, plus a stereo headphone jack. The KA-2000 carries a 2-year warranty on parts and labor.

Circle No. 83 on Reader Service Page 15

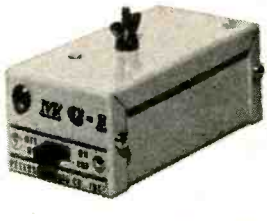
"RABBIT EARS" ANTENNA

Something new in indoor TV antennas! The "Monitor 1000" introduced by *Gavin Instruments* is a "rabbit ears" antenna incorporating fold-away dipoles and a synchronized rotating scanner which makes it unnecessary to rotate the antenna base. The chrome-plated brass dipoles are rugged and highly conductive. Available with either a walnut or sandalwood finish, the "Monitor 1000" is a broadband VHF-FM-UHF unit.

Circle No. 84 on Reader Service Page 15

VHF MOBILE CONVERTER

Your car radio can become a VHF receiver if you install the MC-1 mobile converter developed by *Petersen Radio Co., Inc.* Crystal-controlled to any one frequency from 25 to 175 MHz, the MC-1 tunes to any tube or transistor broadcast radio at 1000 kHz. The unit has a single wing-nut mounting, and incorporates three high-gain silicon transistors, a zener diode voltage regulator, and a panel light indicator. Installation time is less than 15 minutes.



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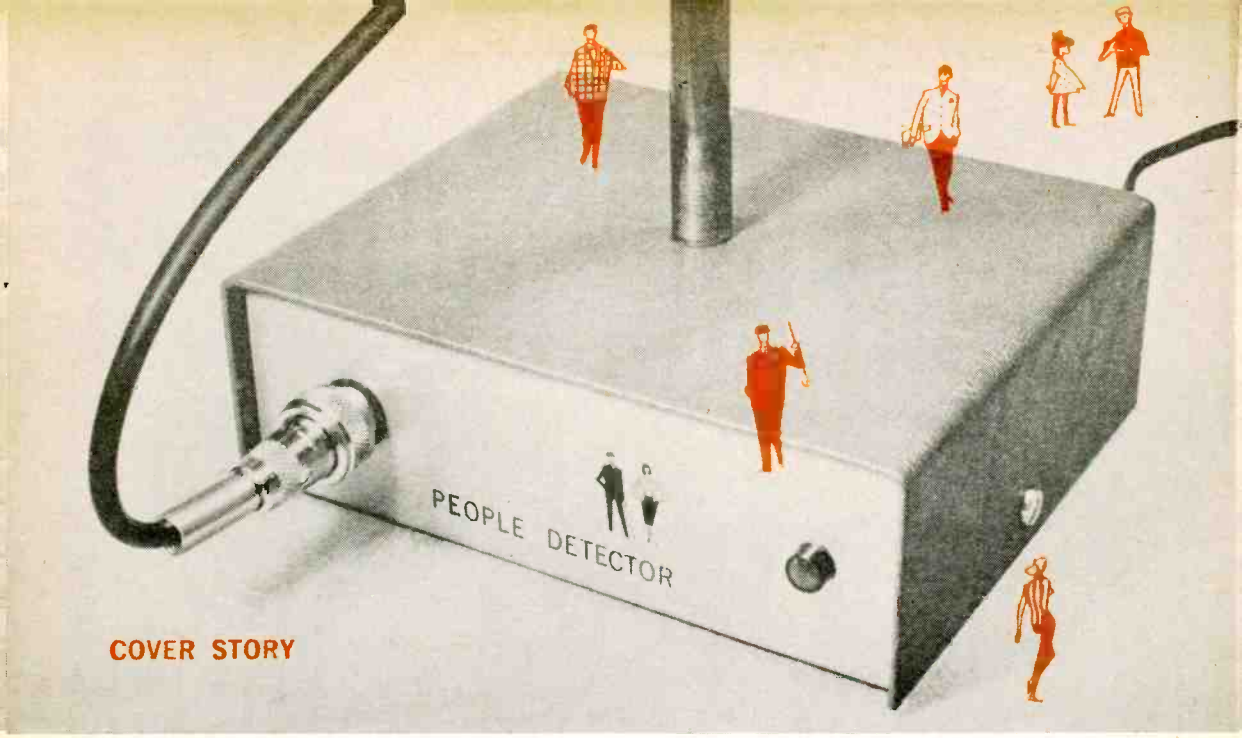


COVER STORY

The Amazing "PEOPLE DETECTOR"

BUILD A 1968 MODEL OF THE FAMOUS PROXIMITY RELAY— 100% PASSIVE— OPERATIONALLY STABLE— 3-FOOT RANGE

BY LOUIS E. GARNER, JR.

THERE ARE many ways to detect the presence of a person by means of electronic techniques such as ultrasonics, light beams (both visible and ultraviolet), microwave radar, r.f. capacitance relays, etc. All of these systems, however, suffer from a common disadvantage: they either radiate or emit some form of signal, and therefore leave themselves open to detection—and circumvention—by skilled intruders having a good working knowledge of electronics.

The tables are now turned, and even the most talented intruder is in for an unpleasant surprise when he comes up against the amazing "People Detector," shown both on the front cover and in the photo above. An entirely *passive* device which does not radiate or emit any type of signal, it cannot be detected or circumvented by conventional means.

Under maximum sensitivity conditions, the "People Detector" can respond to a person coming within several feet of its sensor antenna; and, once discovering an intruder within its protective field, it can sound an alarm, summon a guard, actuate machinery, turn the lights on, op-

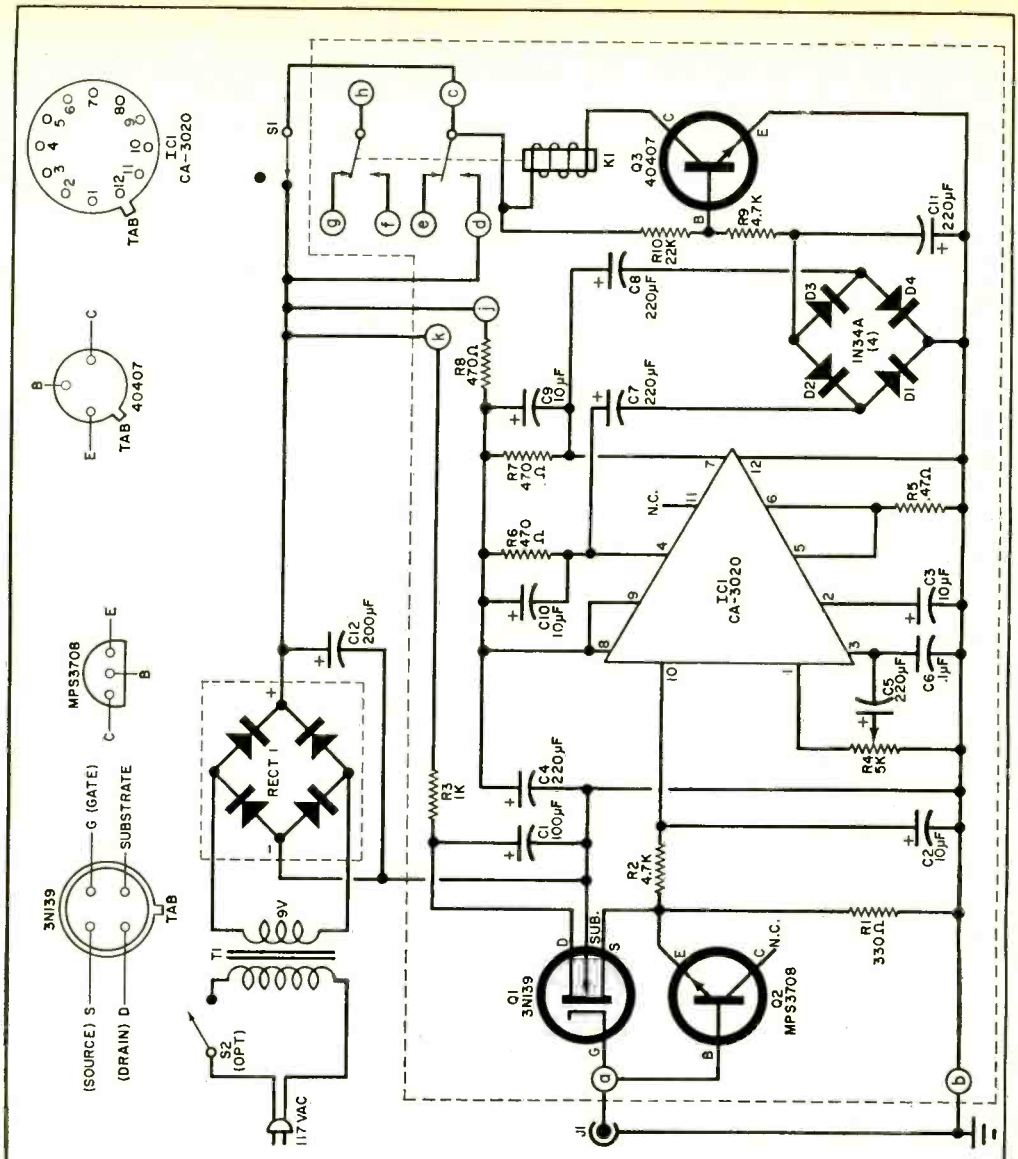


Fig. 1. Because the input impedance is many megohms, do not locate the sensor antenna near any source of r.f. noise, as operational range will be reduced. The metal antenna can be any shape desired.

erate a counter, release tear gas, or perform any task that can be "activated" by an electrical signal.

If desired, the sensitivity can be reduced so that the effective range of the "People Detector" is measured in inches, and the device can then be used as a proximity control for advertising displays, automatic door openers, as a safety or manufacturing control for industrial equipment, as a limit control, and in dozens of other ways. It will even detect the presence of large animals and can serve as a trigger for a flash camera in wildlife photography.

Construction. DO NOT remove the eyelet surrounding the MOSFET leads until instructed to do so later in the text. The "People Detector" circuit in Fig. 1 should be constructed on a printed circuit board such as that shown full size in Fig.

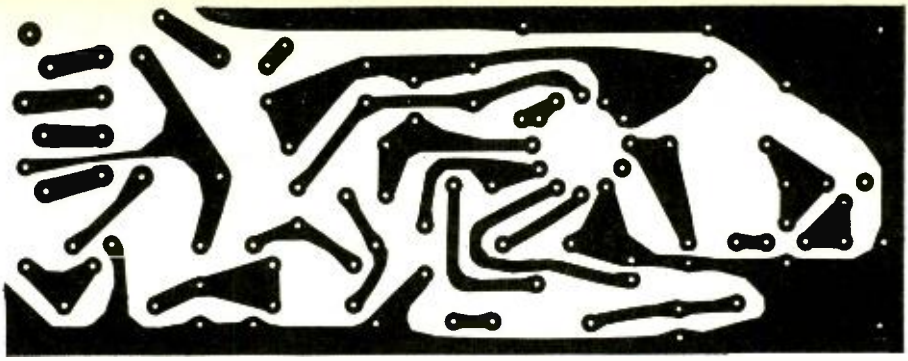


Fig. 2. This actual-size PC board foil layout should be made on a glass-epoxy board, rather than paper-phenolic, to reduce the possibility of poor operation due to stray leakage paths.

PARTS LIST

C1—100-μF, 15-volt electrolytic capacitor
C2, C3—10-μF, 15-volt electrolytic capacitor
C4, C5, C7, C8, C11—220-μF, 6-volt electrolytic capacitor
C6—0.1-μF, 12-15 volt disc ceramic capacitor
C9, C10—10-μF, 25-volt electrolytic capacitor
C12—200-μF, 15-volt electrolytic capacitor
D1, D2, D3. D4—1N34A general-purpose germanium diode
IC1—Linear integrated circuit amplifier (RCA CA-3020)
J1—Coaxial microphone jack (Amphenol 75-PC1M, or similar)
K1—D.p.d.t. relay, 12-volt, 40 mA coil
Q1—3N139 n-channel MOSFET (RCA)
Q2—MPS 3708 npn transistor (Motorola)
Q3—40407 npn transistor (RCA)
R1—330-ohm, ½-watt resistor
R2, R9—4700-ohm, ½-watt resistor
R3—1000-ohm, ½-watt resistor
R4—5000-ohm trimmer potentiometer (CTS X-201, or similar)
R5—0.47-ohm, ½-watt resistor
R6, R7, R8—470-ohm, ½-watt resistor
R10—22,000-ohm, ½-watt resistor
RECT 1—Bridge rectifier assembly, 2 amp (Varo VS-148, or similar)
S1—S.p.d.t. slide switch
S2—S.p.s.t. switch (optional)
T1—Power transformer: primary, 117 volts; secondary, 9 volts, 100 mA (Southwest Technical Products Corp. P9-1 or similar)
Misc.—Etched circuit board, four-lead transistor socket, line cord and plug, antenna plate (copper-clad PC board), short length of RG-58/U coax cable, coaxial microphone connectors (male and female), female chassis-mount line receptacle, 117-volt neon-lamp assembly (with internal resistor), small metal case (approx. 4½" x 6" x 2"), screws, nuts, wire, solder, etc.*
Optional—Lock-type s.p.s.t. power switch, alarm bell or buzzer, alarm power supply, heavy-duty 12-volt battery, power relay

**A pre-etched and drilled circuit board is available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216 for $2.65 postpaid. A complete kit, including circuit board and cabinet, less optional accessories, is available for $18.50.*

2. Use a glass-epoxy base copper-clad board rather than the more common paper-phenolic type to avoid leakage which may reduce sensitivity or impair operation. Remember that you are dealing with a very high input impedance circuit.

Install all the components except *Q1,* after first making sure that the polarity of the semiconductors and electrolytic capacitors are correct, as shown in Fig. 3. Mount a conventional four-lead transistor socket at the *Q1* position.

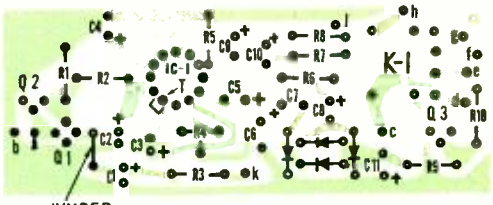


Fig. 3. Component layout of "People Detector." Use transistor socket for Q1.

After the other components have been mounted, and the circuit double-checked, remove the eyelet from *Q1*'s leads, and slip the transistor into the socket, avoiding contact with the gate lead. If possible, install the substrate and source leads first. Once mounted in its socket, *Q1* is protected by *Q2*

For optimum performance, the PC board should be mounted on four short standoff spacers (one at each corner), in a shielded metal housing. A good-quality coaxial microphone jack is used for *J1.* In the author's model, the *K1* "h" and "g" contacts switch a.c. power to a con-

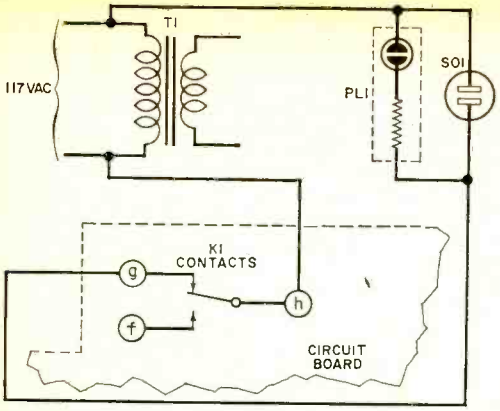


Fig. 1. One method of connecting a power outlet socket to relay K1. PL1 indicates power condition.

ventional a.c. receptacle mounted at the rear of the metal cabinet. This wiring is shown in Fig. 4. A 117-volt neon lamp pilot light assembly (with internal resistor) can be connected in parallel with this outlet to indicate when the outlet is activated.

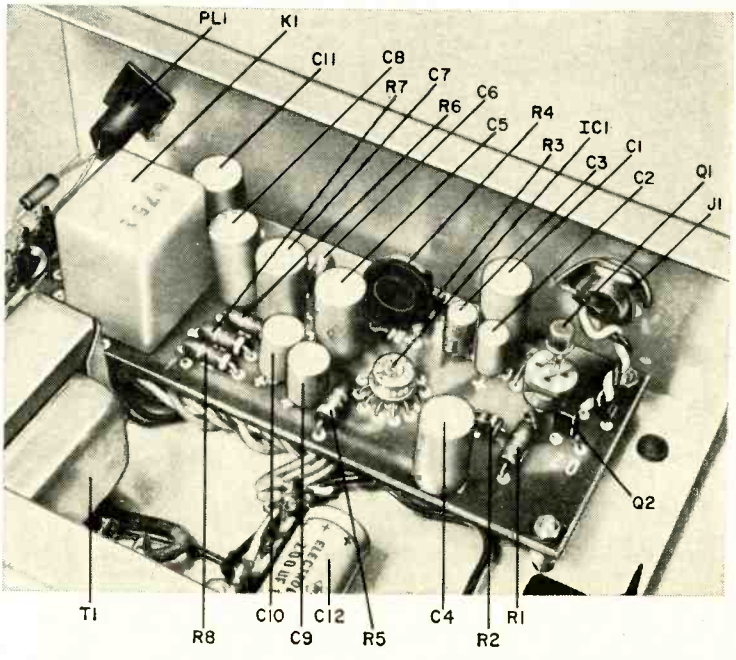
Almost any antenna configuration can be used, ranging from a short length (10″ to 12″) of wire attached directly to the *J1* center terminal to a small metal plate connected to *J1* via a short length of low-capacitance coaxial cable, such as RG-58/U. Only the center lead connects the metal plate to the center terminal of *J1*, so make sure that the coax braid makes contact *only* at *J1*. The metal plate (or copper-clad PC board if you prefer), can range from two to eight inches square, and shape is unimportant.

Several factors determine the maximum sensitivity that can be attained in a given installation: antenna size (metal plate area), connecting coax cable length, and the amount of a.c. "noise" present. As a general rule, the larger the antenna plate and the shorter the connection cable, the greater the instrument's sensitivity. Where possible, the coax cable length should be kept under three feet.

The power supply can be mounted in the same case as the instrument using conventional point-to-point wiring.

Adjustment. Under ideal conditions, and with a moderately large antenna, the unit will respond to a person's movements at a distance of up to eight to ten feet (with *R4* set to maximum sensitivity). In some cases, it may be difficult to achieve this range due to local electrical interference, *i.e.*, local radio transmitters, fluorescent or neon lamp noise, motor noise, or any type of arcing. In such a case, the range may be reduced to three or four feet.

Once the system has been installed,



The neat layout within the device contributes to its excellent operation. Unidentified resistor at far left is the current-limiting resistor selected for operation of the neon lamp (PL1). The relay shown here is a Price Electric 226-24P (furnished with kit), although any other 12-volt, 40-mA coil d.p.d.t. relay can be used with external wiring from the PC board.

adjust *R4* for the desired control range. Move toward (and away from) the antenna sensor plate to activate the instrument. If you require a limited range—2″ to 18″ for proximity control purposes—no difficulties should be encountered. On the other hand, if you are seeking maximum range for intruder alarm or safety control applications and find that adjusting the sensitivity control (*R4*) for maximum gain causes relay *K1* to chatter, you must relocate the antenna plate, use a small antenna, or reduce the gain.

Modifications. Although the author does not recommend changes in the basic circuit, a number of different power supply and output connections can be used to meet individual installation requirements.

For example, a battery (12-volt) can be used in place of the line-operated power supply. You would connect the battery positive lead to the positive input of the "People Detector" (Fig. 1) and the negative lead to the negative input.

The on-off switch (*S2* in Fig. 1) is an optional feature and can be replaced

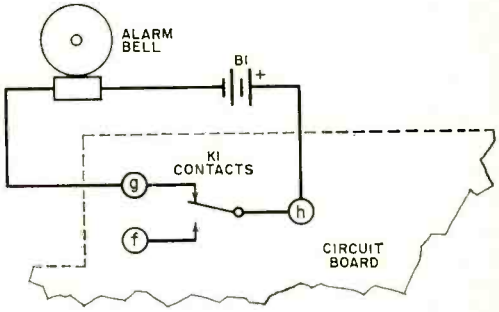
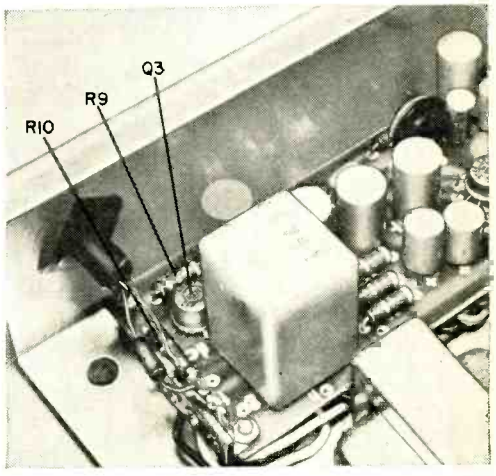


Fig. 5. A remote bell, or other alarm, with its associated battery power can be connected as shown here.



Note location of the 40407 transistor (Q3). A terminal strip is used for neon lamp (PL1) connections.

HOW IT WORKS

The "People Detector" operates by detecting and responding to a *very small* change in its antenna-(sensor)-to-ground capacitance. This action is achieved by an input stage having a very high input impedance—in this case, an insulated gate field effect transistor, or IGFET, usually called a MOSFET, for metal oxide semiconductor field effect transistor.

The sensor antenna is directly connected to the gate of *Q1*, allowing a small static charge to accumulate on the gate. Note that the gate in a MOSFET is not directly coupled to the semiconductor; therefore, the accumulated charge on the gate (ignoring *Q2* for the moment) has no place to go and establishes a fixed bias. The gate charge determines the current flow between *Q1*'s drain (D) and source (S); therefore, any change in the value of gate bias produced by a person approaching the sensor antenna will cause a current flow through *Q1*. Bipolar transistor *Q2*, diode-connected between *Q1*'s gate and source electrodes, is not a functional part of the circuit, but only serves as a zener diode to prevent an excessive gate static charge which could damage the MOSFET.

The output signal from *Q1*, developed across *R1*, is coupled through a low-pass filter (*R2-C2*) to remove the possibility of triggering by nearby radio transmitters, and is passed to the input of an integrated circuit (*IC1*). This IC contains seven *npn* transistors, three diodes, and eleven resistors, which make up a high-gain, wide-band, general-purpose amplifier with push-pull output. The output signal from the IC is generated across *R6* and *R7*, and coupled via *C7* and *C8* to a bridge rectifier made up of *D1* through *D4*. The voltage present across capacitor *C11* will then be proportional to any change in the antenna-to-ground capacitance. Potentiometer *R4* determines the gain of the IC amplifier, hence is used as the sensitivity control.

"Fail-safe" performance is obtained by biasing relay driver *Q3* to its conducting state for normal operation, thus keeping relay *K1* closed. If the operating power, transistor *Q3*, or the relay coil should fail, the relay armature will drop out, closing contacts "g" and "h," and thereby actuating the external alarm equipment. When the detector is activated, the negative voltage developed across the bridge rectifier will "buck" the bias on *Q3*'s base. If the sensor antenna capacitance to ground changes, this bias will then cut off *Q3* to drop out the relay, sounding the external alarm.

Relay *K1* is connected so as to permit optional "latching" operation, as may be required for burglar alarm and safety control applications. Note that *Q3*'s collector and base voltage is supplied through relay contacts "c" and "d," shunted by switch *S1*. As long as *S1* is closed, the instrument resets itself automatically after activation (there is a short inherent time delay built in). If *S1* is open, *Q3*'s collector and base voltage is removed when the relay opens; *K1* remains open (latched) until it is manually reset by closing *S1*.

with a key-operated switch in the interests of safety.

If the instrument is to actuate external equipment requiring relatively large currents (electric motor, horn, heavy-duty solenoid, or any multi-ampere device), a separate power relay controlled by *K1* is required. The "fail-safe" feature can be retained by using a double-pole relay, connecting the external equipment to the relay armature and the normally closed contacts, and controlling the coil power with *K1*'s "f" and "h" contacts. When *K1* opens, the external relay will also open.

Applications. There is virtually no limit to the number of ways in which the "People Detector" can be employed. Generally speaking, however, the instrument's practical applications can be grouped in three broad classes according to the degree of sensitivity needed: long range (3 to 6 feet); medium range (1 to 3 feet); and short range (1 to 12 inches).

Perhaps its most popular long-range application will be in burglar or intruder alarm systems. Here, best results are obtained in installations requiring *point*—rather than *area*—protection, *i.e.*, where the instrument protects a limited critical spot rather than an entire room—typically a safe, vault, file cabinet, desk, rear entrance, or gun case. The antenna is placed close to the item to be protected, while the alarm device (bell, buzzer, lights, or remote line to a guard station) is operated by a separate power supply, and is switched by *K1*'s "g" and "h" contacts as shown in Fig. 5. The unit is set up for "locking" operation (*S1* open).

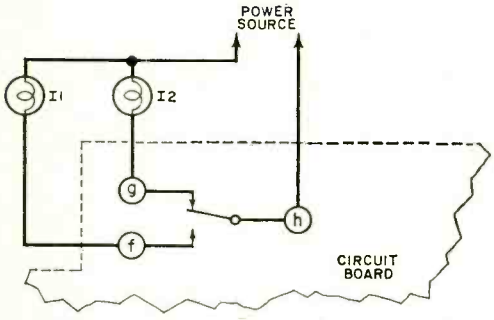
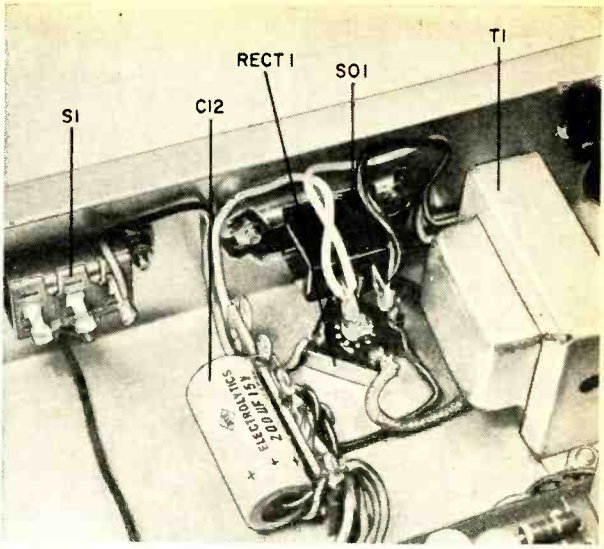


Fig. 6. When someone approaches the sensor antenna, I1 goes off while I2 comes on. This signaling can be used in a number of ways, as explained in text.



Rear apron view shows the location of the power supply, the output a.c. socket, and reset switch S1.

With 12-volt battery operation feasible, the "People Detector" also can be used as an intruder alarm in field applications (camping or boating, for example), in mobile installations (cars, trucks, campers, construction equipment), or in outdoor storage sheds and construction shacks.

Other long-range applications include its use as a safety control or alarm near dangerous machinery or equipment, at the entrances to classified areas, and, as previously mentioned, as a camera/flash control for automatic wildlife photography.

When set up for medium-range operation, the instrument can be used as an automatic doorbell (antenna by front door, *K1* used to operate chimes), to control an electric door opener, as a proximity counter (*K1* actuating an electromagnetic counter), for industrial or commercial installations, and to control advertising displays.

A possible circuit arrangement for an advertising display is shown in Fig. 6. Here, the instrument operates two lamps, *I1* and *I2*. Typically, lamp *I1* could illuminate a sign carrying a message to attract a customer to the immediate area

(*Continued on page* 93)

The SIX Scout

MAKE A NEW 6-METER RIG FROM A GLOBE SCOUT 680

BY R. L. WINKLEPLECK, WA9IGU

THERE ARE MANY excellent, low-cost, low-power, AM, multiband amateur transmitters on the second-hand market that, with a little expense and a few hours of conversion time and effort, will make excellent 6-meter transmitters. Although the conversion to be described was performed on a Globe Scout 680, any other transmitter of the same type can be similarly converted.

Once the conversion is carried out, the transmitter will operate exclusively on 6 meters, a new front panel can be installed, and all unnecessary controls removed. The photos above and below show the difference between the former Globe

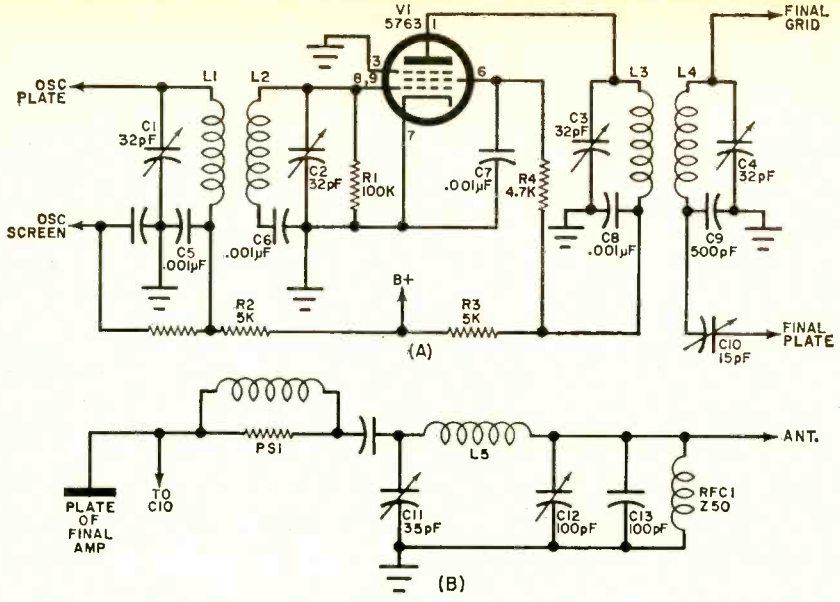


Fig. 1. Circuit (a) is added between oscillator and final. The new output network appears at (b).

PARTS LIST

C1, C2, C3, C4—32-pF variable capacitor, short slotted shaft
C5, C6, C7, C8—0.001-μF, 400-volt disc ceramic capacitor
C9—500-pF, 400-volt disc ceramic capacitor
C10—15-pF variable capacitor, short shaft
C11—35-pF variable capacitor
C12—100-pF variable capacitor
C13—100-pF, 1000-volt mica capacitor
L1, L2—10 turns of 3011 Miniductor, separated 5 turns, with bottom ends adjacent
L3, L4—4 turns of 3011 Miniductor, separated 5 turns, with bottom ends adjacent
L5—3 turns of 3013 Miniductor
PS1—Parasitic suppressor: 6 turns of #22 wire, spaced one-wire diameter on 2-watt, large-value resistor body
RFC1, RFC2, RFC3—Z-50 r.f. choke (see text)
R1—100,000-ohm, ½-watt resistor
R2, R3—5000-ohm, 5-watt resistor
R4—4700-ohm, 1-watt resistor
V1—5763 vacuum tube
Misc.—9-pin socket equipped with shield, 50-ohm, 10-watt resistor (optional), silicon rectifier diodes (2—optional), mounting hardware, wire, solder, etc.

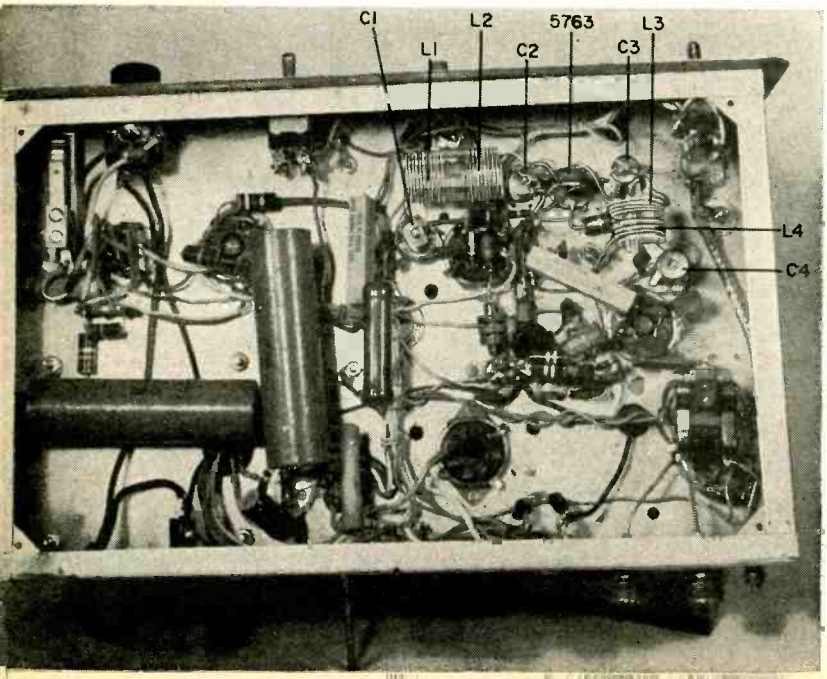


Fig. 2. The new circuit installed in the author's Globe Scout transmitter, replacing the original oscillator band-changing components and output network.

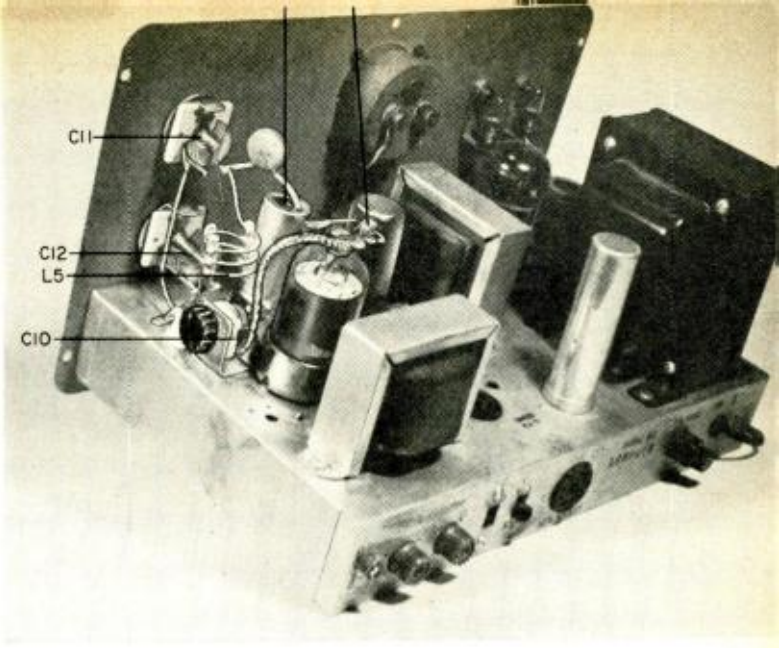


Fig. 3. Mount the above-chassis components as shown here. The new 5763 tube is shielded and the old rectifier has been replaced by a pair of silicon diodes.

Scout and the spanking new Six Scout. In both looks and performance, you will have a 6-meter transmitter that will be the pride of your shack.

Making the Conversion. Remove the oscillator band-changing components (on the Globe Scout, these are *TC3, L1, L2, L4, C5,* and *C6*). Then remove the entire output network between the plate circuit of the final amplifier (6146) and the antenna output (on the Globe Scout, take out *L3, L5, L7, C13, TC1,* and *TC2*). Finally, remove the entire *SW4* switch.

In the void left by the oscillator components, install a 9-pin socket (fitted for a shield), and build up the circuit of Fig. 1(a) as shown in Fig. 2. Physically, this type of equipment is reasonably spacious and no difficulty should be experienced in finding a place for the added components.

Note that inductive coupling is used between stages to insure a clean signal free of harmonics. The added inductors (coils *L1-L5*) are mounted on tie strips, as close to their tube terminals as possible, and at right angles to each other. All leads must be short, and the 5763 tube must be shielded.

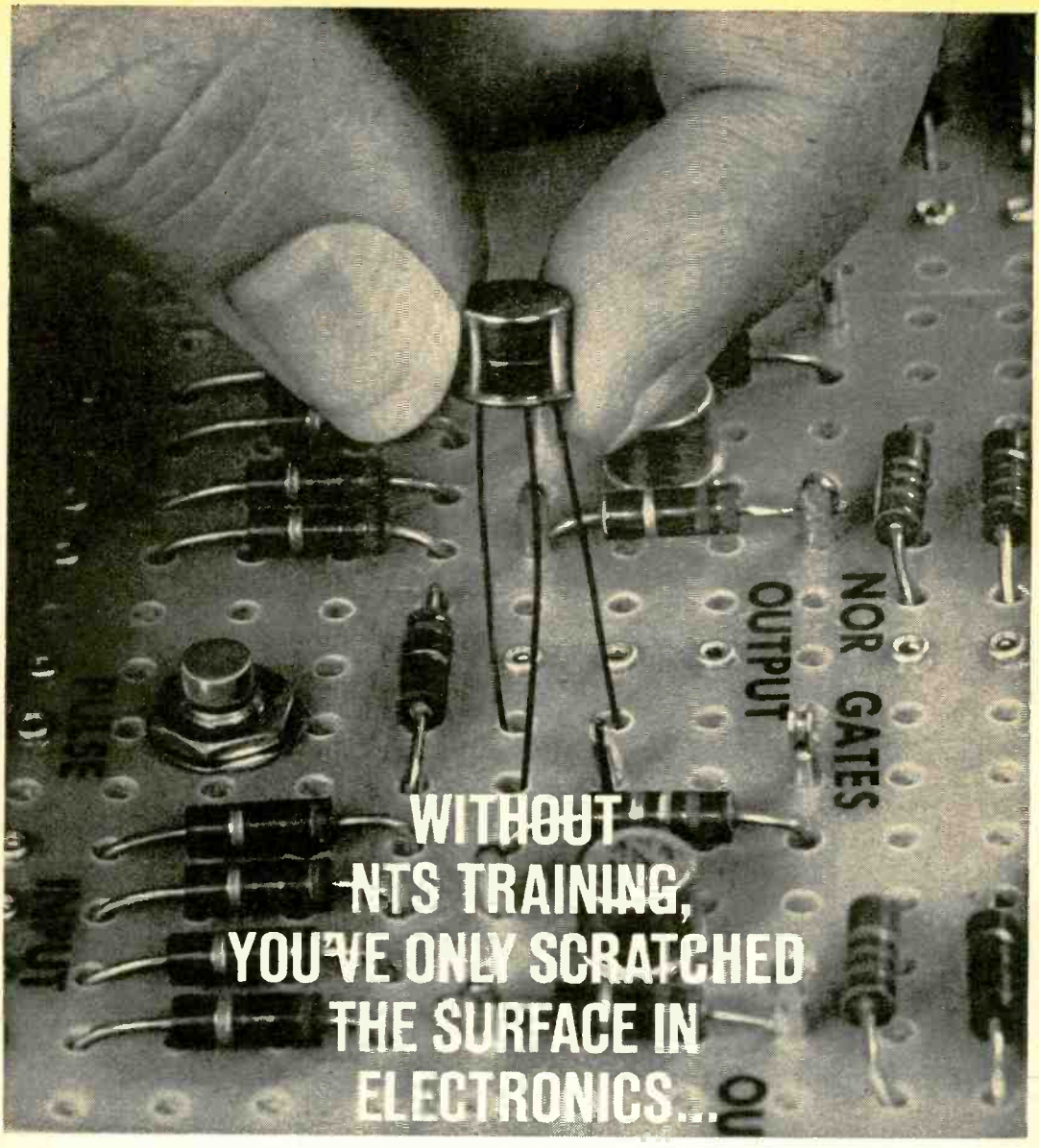
The new 6-meter output network is shown in Fig. 1(b) and is installed in accordance with Fig. 3. Replace the final amplifier (6146) grid and plate r.f. chokes (*RFC2* and *RFC3*) with type Z-50 units, then rewind the plate circuit parasitic suppressor (*PS1*) with six turns of #22 wire, spaced one wire diameter apart.

Neutralization of the final amplifier is made via *C10* which is connected between the plate of the 6146 and the bottom of coil *L4*. This neutralizing capacitor must be insulated from the chassis.

Optional Changes. There are a few other slight changes that improve both operation and appearance. In the model, the rectifier tube (5U4GB) was replaced with a pair of silicon diodes connected in a full-wave configuration. This reduces the heat generated within the cabinet, and also raises the voltage. If you make this change, lift the center tap of the transformer (*PT1*) high-voltage winding from ground, and insert a 50-ohm, 10-watt resistor between the center tap and ground.

Since CW operation was not planned by the author, the phone/CW switch was removed and the circuit wired for phone-only operation. A small relay was installed and wired to a mike switch for a push-to-talk feature, with an extra set

(*Continued on page* 100)



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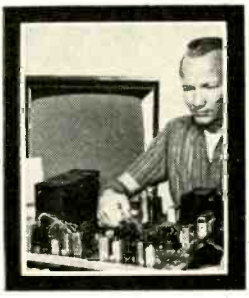

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The QUEST For The Crystal That Amplifies

WE CALL IT A TRANSISTOR—BUT 20 YEARS AGO IT WAS AN UGLY DUCKLING

by Daniel M. Costigan

THE BIRTH of the transistor was not something that happened overnight. It marked the culmination of many years of dreaming and searching, not only by scientists, but by a couple of generations of quixotic tinkerers as well, seeking to extract from a tiny chunk of the mineral galena some magical energy that might eliminate the need for power-consuming vacuum tubes in radio receivers. Some of these experimenters actually produced crystal sets that could operate loudspeakers—at low volume—perpetually and without need for external power.

These devotees of the galena mystique thrived for some thirty years on trial-and-error and wishful thinking. During this time, they were joined by a handful of scientists who worked unnoticed behind the scenes, taking a more methodical approach to essentially the same goal. The scientists were mostly engineers, metallurgists, and physicists who had been recruited by industry—some of them from university faculties—to help seek new ways to improve the efficiency of electric power and communications devices.

Finally, in the late 1940's, the quest for the crystal that amplifies ended in triumph for a trio of distinguished industrial scientists. The year 1968 marks the 20th anniversary of what has since become recognized as one of the most momentous events in the annals of electrical science.

How The Quest Began. The primordial spark to which this quest can be traced occurred around the turn of the century when the need for a practical rectifying device arose almost simultaneously in two budding young industries: electric power, and radio.

In electric power, the advocates of alternating current had won their battle against the d.c. interests and had begun to distribute a.c. power on a wide scale. This meant that some kind of practical converter, other than a motor-generator, would be needed to permit the operation of d.c. apparatus—battery chargers, electroplating equipment, telephonic devices, etc.—on commercial a.c. power.

The rectifying properties of selenium had been known for nearly a century, but it wasn't until 1924 that semiconductor rectifiers became commercially available.

By the early thirties, copper-oxide rectifiers had come into wide use as converters. Selenium, which had at first proved unsatisfactory for use in power conversion, was gradually improved and eventually surpassed copper-oxide in popularity.

The names Mott and Schottky are two that stand out in connection with the early evolution of rectifier theory. Working independently of one another—Sir Nevill Mott in England and W. Schottky in Germany—both men concluded that rectification took place in a thin electrical barrier that formed at the junction of a metal contact and a semiconductor. Schottky called this surface barrier an "inversion region" within the thickness of which a change of conductivity took place. The theory was to play a prominent role in the reasoning that later led to the invention of the transistor.

The "Coherer." Radio's need was for a practical rectifying detector of received signals, and it arose with the advent of voice transmission. In its embryonic stage (1894 to about 1906), a radio receiver had at its heart a "coherer," in which metal filings clung together on exposure to electromagnetic disturbances, thereby varying the current in a local battery circuit. The disturbances were set up by a spark transmitter being turned on and off with a telegraph key.

First used by England's Sir Oliver Lodge in 1894, the coherer* had been steadily improved in design and had reached a fairly high level of refinement by 1900 when Professor Reginald Fessenden of the University of Pittsburgh succeeded in transmitting voice on a continuous wave.

Radio suddenly found itself faced with much the same situation that had created the need for rectifiers in the electrical industry. The transmitted radio wave became a "carrier," its cargo a modulation envelope that was electrically self-cancelling until the alternating current could be made to flow in one direction only. Radio detection thus became a matter of rectification.

Fessenden's first detector was an electrolytic device of his own design. It was highly sensitive, but also critical and unreliable.

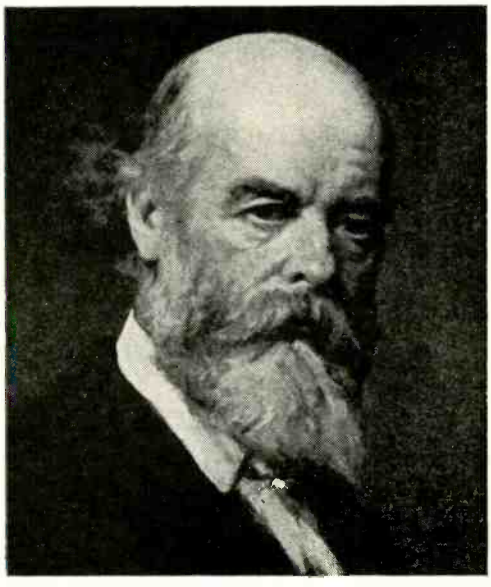
The first practical crystal detectors appeared in 1906. The one invented by G. W. Pickard used silicon and featured a "catwhisker" (fine wire) contacting arrangement similar to that suggested by a German experimenter named Braun some 30 years earlier. Another type, invented by H. H. Dunwoody, an executive of the De Forest Wireless Company, used a small chunk of carborundum clamped between two electrodes.

Vacuum Tubes and Diodes. The crystal detector reigned supreme until the early twenties when the vacuum tube began to make inroads. Silicon had proved to be the most stable crystal, but galena (lead sulphide) was the most sensitive and therefore the most popular.

As in everything, however, it takes power to beget power; thus, there were the inevitable "A" and "B" supplies wherever vacuum tubes were used. What's more, some of the power had to be wasted in heating the tube filament—an unfortunate requisite that was to impose serious restrictions on the tube's useful life and on the design of the tube-using equipment.

Crystal detectors needed no external

Sir Oliver Lodge (1851-1940) made many important contributions to wireless transmission and reception, which led to UHF transmission techniques.



For more details, see article entitled "The 'Coherer'" which appeared in the May, 1967, issue of POPULAR ELECTRONICS.

power supply; they were simple and compact, and there was no heat problem. But they couldn't amplify—at least not until a group of scientists at a major industrial research laboratory had undertaken an intensive investigation into the mysteries of solid-state semiconductors.

In 1934, the Bell Telephone Laboratories began to develop fixed semiconductor diodes for use in microwave experiments. The earlier ones were silicon and germanium point-contact devices resembling the "fixed" detectors that had been used in some crystal broadcast receivers. ("Point-contact" is a sophisticated term for the old familiar catwhisker.) The more advanced junction diodes were developed during and immediately following World War II.

A New Turn. Walter H. Brattain had come to Bell Labs shortly after having received his Ph.D from the University of Minnesota. His involvement during the thirties in the study of electrical conductivity in semiconducting materials eventually brought him in contact with William Shockley, a brilliant young Ph.D who joined the staff in 1936 and soon began to form some ideas of his own on the potentials of semiconductors.

In that same year (1936), Dr. Mervyn Kelly was appointed Director of Research at Bell Labs, and one of his first acts was to assemble a team of physicists to formally explore the behavior of electrons in solids. Brattain and Shockley were among those selected.

Professor Reginald Aubrey Fessenden (1866-1932), a pioneer in wireless communication, was the first man to voice-modulate a continuous-wave carrier.

Since the late thirties, Shockley had been entertaining the notion that a semiconductor ought somehow to be able to amplify an electric current. His attempts to achieve "valve action" in a copper-oxide device were interrupted by World War II. Immediately following the war, he constructed a special device based on a scheme he had worked out on paper. But, as is so often the case, what appeared workable on paper did not work in actuality.

Ironically, the device that had failed was the forerunner of the field-effect transistor (FET), which was to re-emerge many years later to be heralded as one of the more important advances in solid-state technology. Had Shockley's experiment been successful—if more had been known about the characteristics of semiconductor materials—the development of solid-state devices might have taken a completely different course.

It was about the time of Shockley's "field-effect" experiment that the Bell Labs team was enhanced by the addition of a new member. He was John Bardeen, a 37-year-old theoretical physicist and former university professor whom Shockley had personally recruited. During the preceding decade, Bardeen had done extensive work in the field of electroconductivity in solids. The fact that Shockley's experiment had not yielded the expected result interested Bardeen and set him working on a theory to explain why.

Breakthrough. Taking his cue from Mott and Schottky, Bardeen theorized that surplus electrons gathered at the surface of a semiconductor and became immobilized so that, in effect, they acted as a sort of barrier to externally applied currents. To test his "surface states" theory, he and Brattain performed a series of interesting experiments.

At first they used a liquid electrolytic as a current-carrying medium between one side of a power source and the surface of a piece of semiconducting silicon. They found that by passing a current through the electrolyte, the surface

charge on the silicon could be altered.

This led Brattain to suggest a slightly modified approach. Germanium was substituted for silicon, and a thin layer of gold for the electrolyte as the special contacting interface. Two currents were made to flow in opposite directions through the germanium, one between the gold contact and a solid connection at the base of the material, and the other between the base connection and a catwhisker contacting the surface near the gold contact. As had by now been anticipated, varying the one current produced corresponding variations, *but of greater magnitude,* in the other. Amplification had been achieved!

The technical explanation for the phenomenon was highly complex and dealt with such things as atomic valences, "holes," "donors," and "defect conductivity." Stated simply, what had happened was that the tiniest *plus* charge at one of the two contact points on the semiconductor surface had drawn off enough of the material's surplus electrons to create "holes," which, in turn, were attracted to the adjacent negative point and therefore functioned as vehicles by which the lesser current could influence the greater one. In essence, then, the semiconductor had become a variable resistance, enabling control of current flow in one circuit by varying the current in another.

By the close of 1947, experiments had proved the new device capable of amplifying audio frequency signals. Bardeen and Brattain quietly announced their discovery via a letter to the editor of "The Physical Review," published in the July 15, 1948, issue.

The First Transistors. The name *transistor*, by which the device was to become known, was suggested by another Bell Labs physicist, John R. Pierce. Pierce observed that, where a vacuum tube amplified by transconductance—the effect of the grid voltage on plate current—the new device did its amplifying by what might more aptly be termed "transresistance." The name may also be thought of as suggesting the *trans*fer of signals through a var*istor*, a varistor being a semiconductor diode whose electrical resistance decreases substantially with a moderate increase in applied voltage. (Varistors are often used as buffers to protect delicate components from voltage surges.)

The first transistors produced in quantity in the laboratory contained a tiny chunk of slightly impure germanium on which two "catwhiskers" converged, *contacting* the surface at *points* less than a hair's breadth apart.

William Shockley, meanwhile, continued to pursue his own ideas on how best to make a semiconductor amplify. His quest led to the invention, later in 1948, of the *junction* transistor in which transistor action was achieved by the sandwiching together of *p*-type (electron deficiency) and *n*-type (electron surplus) semiconductors. Shockley's design, although at first more difficult to fabricate, proved more predictable in its properties and less fragile than its "point contact" predecessor, and was therefore soon to supersede it. The junction transistor was introduced early in 1951.

Overcoming Obstacles. A major obstacle to mass production was the requirement that semiconductor materials contain carefully controlled degrees of impurities to insure the proper electrical imbalance. This meant starting with a nearly pure substance and then adding adulterants (such as arsenic or gallium) by a carefully controlled doping process. The introduction of zone refining in 1955 was the first big breakthrough in high volume production of the basic materials.

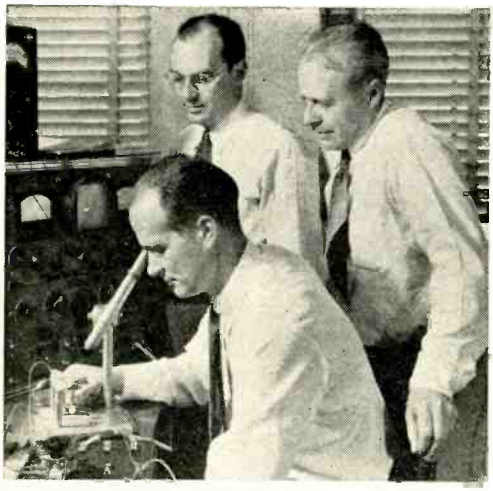
In recognition of the magnitude of the revolution they had kindled, the transistor's trio of inventors—Shockley, Brattain, and Bardeen—were awarded the 1956 Nobel Prize in Physics.

But, during the middle fifties, the widely acclaimed little device still suffered a number of serious shortcomings. For one thing, it was critically temperature-sensitive and therefore unable to handle power beyond a fraction of a watt. What's more, it was noisy and unstable, had ridiculously low input impedance, and was a sluggish device whose switching speed and frequency response left much to be desired.

These shortcomings, however, were gradually overcome as new manufacturing processes were introduced and semiconductor materials with improved elec-

trical characteristics were developed. By the late fifties, the reliability of the device had already begun to exceed that of vacuum tubes.

The year 1957 was the best ever for the sale of vacuum tubes. Unit for unit, they were still outselling transistors by thirteen to one. But the gap was rapidly narrowing, with the turning point due in the early sixties. (In 1959, 77.5 million germanium transistors were sold for a total of 151.8 million dollars, at an average price of $1.96 per unit. By 1966, the picture was considerably changed: 368.7 million units were sold for a total of 164.5 million dollars, an average price of 45 cents each!)



William Shockley, John Bardeen, and Walter H. Brattain, co-discoverers of the transistor, received the 1956 Nobel Physics Award for their invention.

Further Improvements. New developments followed in rapid succession, and with them came a whole new electronics vocabulary: *p*-type, *n*-type, bipolar, diffused junction, epitaxial growth. The grown junction gave way to the alloy junction, which, along with the introduction of the diffusion process, resulted in improved frequency response and switching speeds. It was now feasible to use transistors in computers—a marriage which, in turn, was to enhance the evolution of still faster and more reliable semiconductor devices.

The diffusion process also broke the transistor's power-handling and temperature barriers by facilitating the use of silicon in place of germanium. Mesa, planar, and epitaxial devices emerged as some of the more prominent offshoots of the diffusion technique.

The field-effect transistor, which had continued to lie dormant in the laboratories, seemed to hold the key to some of the improvements still needed—higher input impedance, for example, and lower levels of noise and distortion. Of all semiconductor devices, it came closest to a vacuum tube in characteristics. But the electrical surface properties of the semiconductor material used in its fabrication were critical, and it was not until recently that FET's finally became competitive with other semiconductors.

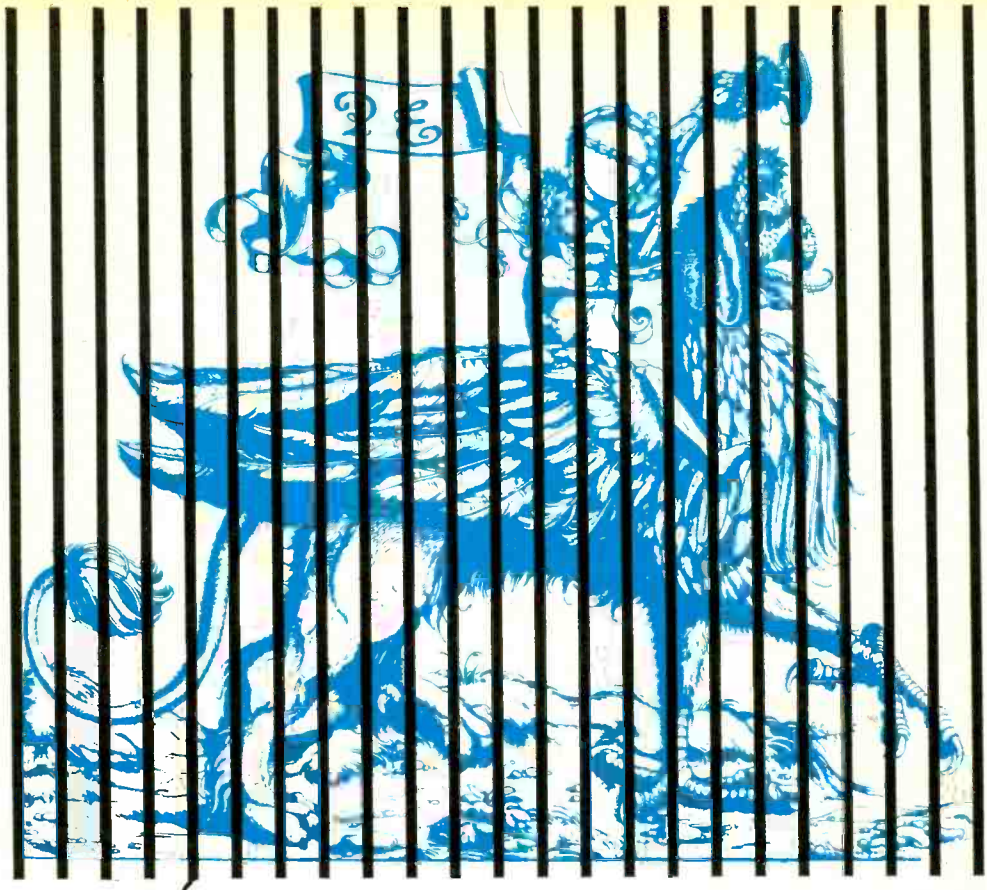
Similarly, the unijunction transistor, with its single *p-n* junction, was originally developed in the early fifties, but is just now beginning to emerge as one of the less expensive, more stable, and temperature-resistant devices.

The late fifties saw the introduction of miniature circuit modules, silicon-controlled rectifiers (SCR's), and Esaki's remarkable tunnel diode, with which amplification was possible without the traditional "third element." SCR's shrunk the gap between tube and semiconductor capabilities by providing a highly efficient solid-state replacement for thryatrons and mercury-arc rectifier tubes in power control equipment.

What Does The Future Hold? The pace of development of new transistor types has been absolutely staggering. The list now numbers in the thousands, and it continues to grow as the mighty midget celebrates its 20th birthday.

Apart from its having reshaped an entire industry and opened many new doors, perhaps the most fascinating offshoot of the whole solid-state technology to date has been the subordinate art of microelectronics. Already in the making are integrated circuits so minute that an entire amplifier could hide behind a single transistor.

Solid-state technology has been growing and changing at such a dizzying pace that it is difficult to predict what lies ahead even in the next year or so. Perhaps at this very moment, somewhere in the world, a small but persistent group of experimenters is exploring a radically new concept that may someday render the present technology obsolete. —30—



WANT TO KEEP YOUR MYTHICAL BEASTS AT BAY? WHAT COULD BE BETTER THAN AN

ELECTRIC FENCE

BY LYMAN E. GREENLEE

ONE OF LIFE'S lesser pleasures is hearing your neighbor's cat or dog upset your metal garbage can—at four in the morning! Or, worrying about those expensive new evergreens the landscaper planted that afternoon. Or, listening to snooping animal sounds outside your summer cottage. Or, trying to think of a way to keep that frisky horse, cow, or lamb in its pasture.

With an electric fence, you can forget about any or all of these problems. Presented here is an inexpensive electronic system* that will deliver a disturbing (but harmless) electrical sting to any animal or person touching the item to be pro-

*This project is a solid-state version of the "Electric Fence Charger" which appeared in POPULAR ELECTRONICS, December, 1964.

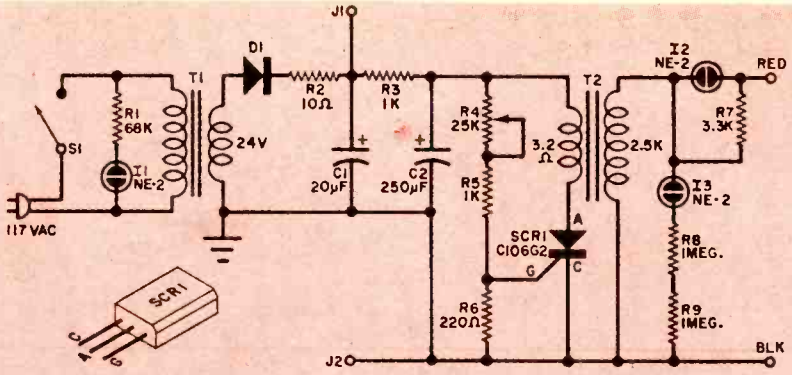


Fig. 1. The device can be powered either from an a.c. power line or from a conventional 45-volt "B" battery. There are no critical parts or adjustments.

PARTS LIST

C1—20-μF, 50-volt electrolytic capacitor
C2—250-μF, 50-volt electrolytic capacitor
D1—Silicon rectifier, 100 PIV, ½ ampere
I1, I2, I3—NE-2 neon lamp (without resistor)
J1, J2—Banana jack (one red, one black)
R1—68,000-ohm, ½-watt resistor
R2—10-ohm, ½-watt resistor
R3, R5—1000-ohm, ½-watt resistor
R4—25,000-ohm, screwdriver-adjust potentiometer
R6—220-ohm, ½-watt resistor
R7—3300-ohm, ½-watt resistor
R8, R9—1-megohm, ½-watt resistor (do NOT use a single 2-megohm resistor)
S1—S.p.s.t. switch
SCR1—Silicon-controlled rectifier (GE C106G2, or similar)
T1—Power transformer, 24-volt secondary, ½ ampere
T2—Output transformer, 2500 ohms to 3.2 ohms
Misc.—Metal or plastic case, aluminum front panel to fit case, terminal strips, snap-in plastic neon lamp holders (one red, one orange—see text), lengths of red and black insulated test prod flexible wire, hookup wire, solder, hardware, etc.

A complete kit of parts, including drilled panel, is available from Lyman E. Greenlee, P.O. Box 1036, Anderson, Indiana 46015. Order kit FC-2, $24.95.

tected—or making contact with a simple single-wire fence surrounding the area to be protected.

The fence charger has other applications as well. Since it is capable of flashing a conventional fluorescent lamp bright enough to be seen some distance at night, it can be used as a temporary emergency obstruction light. Or it can serve as a homing light—when placed on a fishing dock, for example. And, because it can be powered by a conventional 45-volt "B" battery, the project can be used anywhere, regardless of the presence or lack of a power line.

Construction. The circuit, diagrammed in Fig. 1, can be built in a metal or plastic utility box. Parts layout is not critical, and all components can be affixed to the front metal cover as shown in Fig. 2. This type of construction makes for easy assembly, wiring, and troubleshooting—in the event that it should ever become necessary. If a metal box is chosen, make sure that none of the components touches the metal to cause a possible short circuit.

Use a heat sink (long-nose pliers on each lead) when soldering the SCR, and toothed lock washers and soldering lugs for all chassis connections. For ease in output identification, use a red-insulated wire for the high-voltage lead and a black-insulated wire for the ground lead (see Fig. 1). "Power on" indicator *I1* should be housed in a red plastic holder, while "operation" indicator *I2* should have some other color plastic holder (orange, for example). Lamp *I3* is contained within the box and requires no plastic mounting.

Operation. Make sure that the far end of the red output lead is not touching anything, then turn on the a.c. power (via *S1*). "Power on" indicator *I1* should glow. When the power is applied for the first time, wait for a few minutes to allow the filter capacitors to form proper-

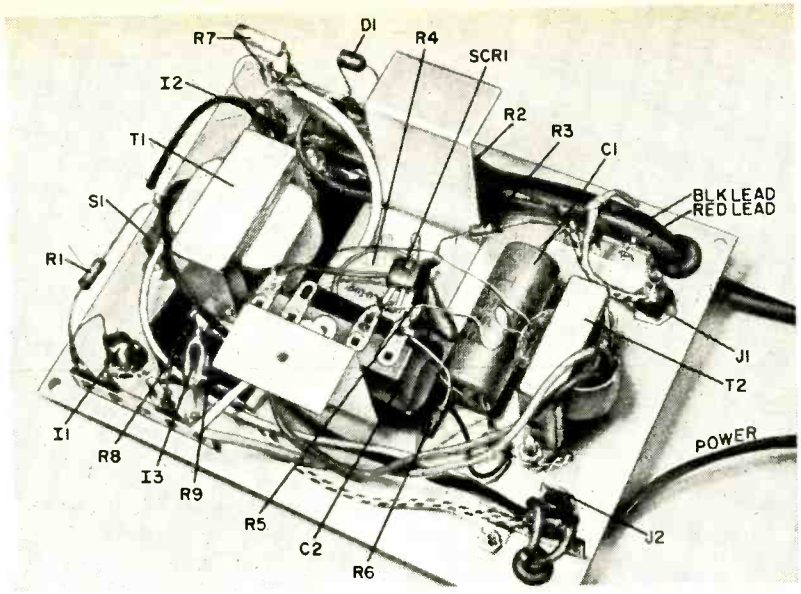
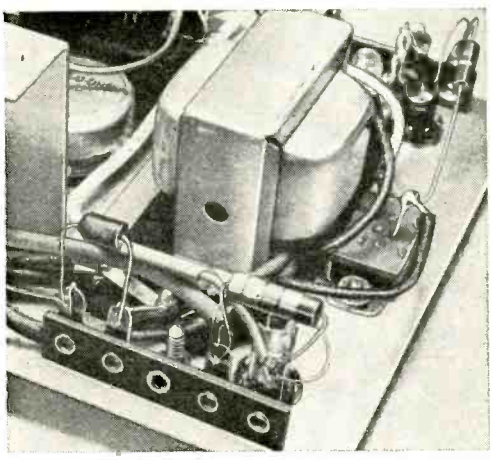


Fig. 2. All of the parts can be mounted on the rear of the enclosure cover plate.

ly. During this initial forming period, the charger will not operate.

After a few minutes, turn off the a.c. power and connect the red and black output leads to a fluorescent lamp (20 watts or more is preferred). Turn the power back on and you will see that the lamp will flash each time the circuit fires. Adjust *R4* until the lamp blinks at between 30 and 40 times per minute. This rate is about right for general operation. The rate will vary with temperature, but such variation is not important since the pulse frequency is not critical.

A 45-volt, heavy-duty "B" battery can be used to power the charger in remote applications far from commercial power lines. Connect the battery positive terminal to *J1* and the negative terminal to *J2*. Because power on/off switch *S1* will not control the device in this mode, you should disconnect the battery when the device is not actually in ser-

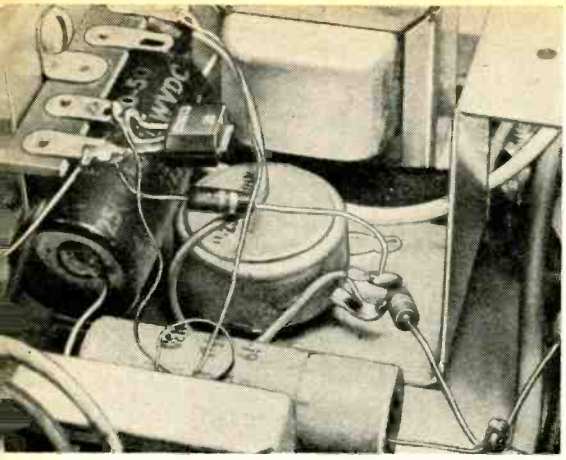


Terminal strips are used to support components and also act as tie points for the point-to-point wiring.

HOW IT WORKS

Isolation transformer *T1* steps the input line voltage down to 24 volts, which is rectified by *D1* and filtered by the combination of *R2*, *C1*, *R3*, and *C2* to produce about 45 volts d.c. This voltage would be applied across the 3.2-ohm winding of *T2* if it were not for the nonconducting SCR which acts as an open switch. As *C2* charges, the voltage across the SCR gate network (*R4*, *R5*, and *R6*) builds up. When the SCR gate receives the required trigger voltage, the SCR fires to discharge *C2* across the *T2* primary. As soon as this discharge occurs, *C2* has essentially no voltage across it, the SCR returns to its nonconducting state, and the cycle repeats itself. Triggering rate is determined by the setting of *R4*.

The turns ratio of transformer *T2* is such that several hundreds of volts are generated across the secondary for each primary current pulse. This voltage spike is passed, via *I2*, to the main high-voltage output (the red terminal). Neon lamp *I2* will flash each time a load appears across the high-voltage output and ground (black terminal). Although disturbing to both animals and humans, the generated shock pulse will cause no damage and is safe due to its very short duration.



The U-shaped metal pan acts as a support for the front panel to prevent panel distortion.

vice. In these remote applications, make sure that both the battery and the charger are kept within a water-proof container at all times.

You can check the operation of the power supply portion of the circuit during power line operation by means of *J1* and *J2*. Connect a 50-volt voltmeter positive lead to *J1* and the voltmeter common to *J2*. The meter should indicate about 45 volts.

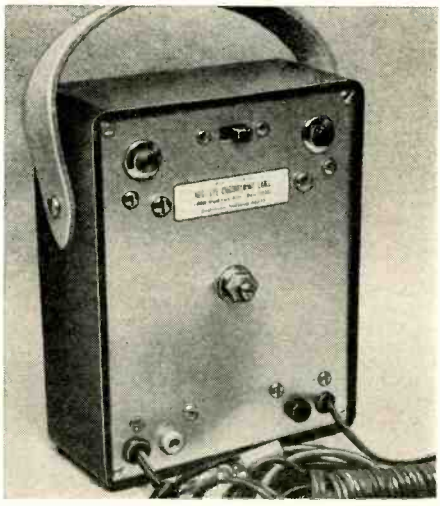
Installation. To keep a metal garbage can from being raided, place a small piece of insulating material (plastic, dry wood, or cardboard) under the can to insulate it from the ground. Then connect the red lead from the charger to the can proper, and connect the black lead to a good ground stake near the can. If the ground near the can is slightly moist, the device will work better.

If the can is usually kept on a dry cement or gravel walk, first lay down a piece of metal screen a couple of feet larger in diameter than the garbage can to serve as the ground. Then insulate the can from this ground with a piece of plastic, dry wood, etc. Connect the red lead to the can, and the black lead to the screen. In both cases, ALWAYS be sure that the charger is turned off before a garbage collection—or you may have another kind of trouble!

Any metal object can be protected in the same manner, provided that it is insulated from the ground, and that an intruder must stand on the ground (or a metal screen) in order to touch the metal object.

To make an electric fence, mount a series of electrical standoffs, one to each fence post, along the area to be protected. The height above ground is dependent on the animal you want to keep out (or in), and should be about knee to chest high for most applications. Then run a bare metal wire through the insulators with the far end terminated with an insulator (do not ground this end or any point along the wire), and the near end connected to the red output terminal (high voltage). Drive a metal rod into the ground for the black (ground) lead. A metal fence post or waterpipe can also be used.

Almost any arrangement can be employed to protect various areas, as long as you remember to have the high-voltage lead (red) connected to a bare wire (supported off ground by insulators), and have a good ground connection for the black lead. In very dry soils, it may



The author's unit is mounted within a black plastic case fitted with a carrying handle.

be necessary to provide some form of moisture to insure a good ground contact.

To use the charger as an emergency lamp flasher, simply connect the red and black output leads to each side of a fluorescent lamp (pins not important). A 20-watt lamp can be seen for miles at night. —30—

Our TV Service Technicians Are Underpaid

THE DEMAND FOR COLOR TV TECHNICIANS IS ON THE INCREASE, BUT SALARIES ARE LAGGING BEHIND

BY FOREST H. BELT

This is a Special Report—one of a continuing series that POPULAR ELECTRONICS is publishing on Jobs & Careers In Electronics. For many years the TV technician has been a "whipping boy" for the sometimes irresponsible customer. Some customer gripes are justifiable, but many are not, since they can be traced to poor wages. Because the skills required of TV technicians are far out of proportion to their wages, and because technicians are not "unionized," the best men sooner or later leave the field. This Special Report tells what the salary situation is around the country, and offers a number of recommendations for improving the overall picture.

The Editors

LOW PAY, long hours, poorly designed receivers, irascible customers—this is the picture old-timers paint for newcomers to the home-electronics servicing field. And, to some extent, not without due cause. At one time or another, all these problems have plagued the man who makes his living keeping the TV receivers of the nation operating.

Today, enlightened TV set manufacturers try hard to design serviceability into their products. Customers, after 20 years of learning what TV can and can't do, have mellowed; the really troublesome customers are few and far between. The only remaining factor that deserves more than passing concern is wage scales.

To find out at what level pay scales now stand, the author recently made a nationwide survey. The results reveal

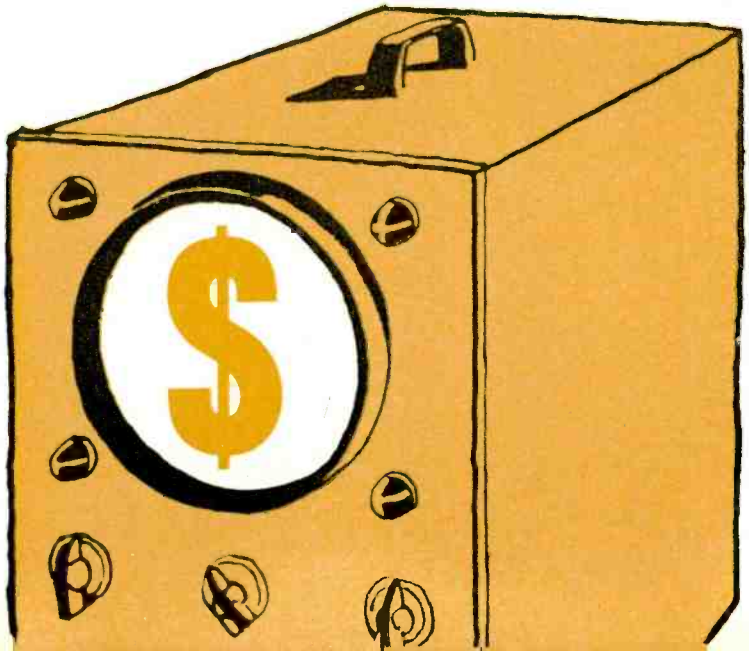


TABLE 1: REPORTED WAGE LEVELS BY GEOGRAPHIC REGION

REGION	APPRENTICE			OUTSIDE			BENCH		
	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW
WEST	3.00	1.90	1.65	5.50	3.50	2.00	5.50	3.80	2.30
CENTRAL	2.50	1.65	1.00	5.00	2.75	1.50	5.00	3.35	2.00
EAST*	2.25	1.65	1.00	3.25	2.65	2.50	4.00	3.20	2.75

Excludes New York City

some thought-provoking patterns, not only geographically, but as to who gets paid how much and why. The pay scales can even be compared to wages in other skilled trades.

Regional Pattern. Table 1 shows how the wage scale pattern evolves regionally. The averages are derived from the entire survey sample in each category; the highs and the lows may represent a single return, although single unnatural highs or lows were eliminated to avoid distorting the picture.

"Apprentices" are classified as men with little formal electronics training and less than two years experience. "Outside" technicians are considered to have at least two years training and two to five years experience. Technicians with more than five years experience are in the "Bench" classification.

There are distinct wage differences in the three major geographic regions. The West seems to pay TV technicians more than either the Central or East regions. The East appears unnaturally low.

Population Factor. Table 2 shows the information used to make up Table 1 resorted to analyze how population affects the wage patterns. There is a sharp change in wage scales around the quarter-million population level. Cities with less than 250,000 people have lower wage levels than cities with more people. However, wages are significantly lower in the million-plus cities than in cities in the 250,000 to 1 million level.

The population-oriented pattern (Table 2) reveals some practical and valuable information. Consider the TV technician apprentice—the beginner in TV servicing. The averages suggest that his prospects are better in a small city—between 50,000 to 250,000 people. There seems to be a greater demand for new trainees in small cities, possibly because experienced technicians have gravitated to the higher wages available to them only in the somewhat larger cities.

The law of supply and demand is probably the reason for the disparity between wages in the medium-sized city and the wages in the major metropolitan

TABLE 2: REPORTED WAGE LEVELS BY POPULATION GROUP

POPULATION GROUP	APPRENTICE			OUTSIDE			BENCH		
	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW
UNDER 50,000	2.25	1.55	1.00	3.15	2.25	1.50	5.00	3.15	2.50
50,000 TO 250,000	2.50	2.05	1.50	4.00	2.85	2.00	4.00	3.20	2.00
250,000 TO 1 MILLION	3.00	1.70	1.00	4.50	3.15	2.00	5.00	3.65	2.30
OVER 1 MILLION	2.50	1.65	1.00	5.00	2.90	1.85	5.50	3.35	2.50

areas. With a larger labor force in a large city, it is natural that more TV technicians are available. Shop owners don't have to pay as much to hold satisfactory employees. Trained TV technicians—on the average—do better in the not-so-huge cities.

In small towns and cities, wages seem always to be lower. This fact is usually offset by reduced living costs, primarily rents and the cost of personal services. However, it's obvious that no man with a family could afford to be an apprentice TV technician in any except the higher-paying shops.

"... no man with a family can afford to be a TV technician ..."

"Big City" Wages. One factor revealed by the survey doesn't show up in the tables. The only reports of wages being above $5 an hour came from very large cities: Chicago, Detroit, Los Angeles, and New York. This is not to say these top incomes aren't available elsewhere, but their likelihood outside the giant cities is remote.

The TV service technician working in medium and large cities fares about equally with workers in other skilled trades. A limited investigation into this facet of the wage picture turned up the following figures in the New York City area.

Computer programmers and key-punch operators make $3.50 to $5 an hour, trainees usually $3; lab technicians (medical), $3 to $4.50 an hour; lab technicians (electronic), $3 to $5; machinists, $3 to $5; maintenance mechanics, $3 to $4.50; teachers, $2.75 to $6; technical writers, $4 to $6.50; temporary *unskilled* help, $2; and truck driver/delivery men, $3 an hour and up.

The Brain Drain. Home-electronics servicing loses an inordinate number of practitioners to "industry" each year. There are several reasons, but the outstanding one is that large companies make the employment package more attractive than the small radio/TV service shop.

Sometimes the bait is a better salary, but not as often as you might think. Frequently the difference lies in fringe benefits. Company-paid or shared hospitalization insurance, paid vacations and holidays, aid in broadening education, sick leave, more satisfactory working surroundings, retirement pension plans, Christmas bonuses, and so on. Some of these benefits may be offered in the TV servicing industry, too, but very sparingly. The only fringe benefits that seem general among service-shop employees are paid 2-week vacations and holidays, and health insurance (usually shared). A few shops furnish uniforms or shirts, if wearing them is required.

Where there are service-technician unions, the fringe-benefit package is better—pensions, longer vacation (3 or 4 weeks for long-time employees), better health insurance plans, more paid holidays, etc.

With good technicians in short supply in many localities, it isn't uncommon to see newspaper ads with offers of inflated salaries. Some figures are real. Others depend on a long, long work week, and perhaps even on commissions from selling receivers or accessories.

A TV dealer in Ohio warned of another high-wage gimmick. A good technician was wooed away from his small-shop job paying $150 a week by an offer of

"... a serious problem is finding ways to upgrade wage levels ..."

nearly $200 a week. Working hours were normal; no commissions or selling were involved. However, as it turned out, he was hired during a rush period, and his high salary was an emergency measure. After 10 weeks, he was laid off.

The home-electronic servicing business in most areas faces a serious problem

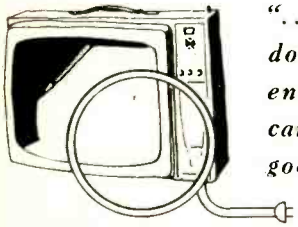
in finding ways to upgrade wage levels and bring them into line with the remainder of the electronics industries. It's that, or live with the prospect of gradually losing all the good technicians. The TV industry can't afford the black eye of repeated accusations of incompetence.

What Can Be Done. There are two sides to the wage picture, and they are clearly delineated. The technician who is underpaid wants to know how he can earn more. The radio/TV shop owner wants to know how he can pay more. The solution has to be a joint accomplishment. One section of our survey uncovered some glaring flaws—several so flagrant they should be obvious. A technician who is on the low end of the pay scale can often do a lot about eliminating these flaws himself.

The importance of a *neat personal appearance* was mentioned more often in our survey than any other quality. This is no indication that any shop owner wants untrained "dandies," but the owner is certainly looking at prospective employees with an eye to what customers may think of them. Neatness is so easy to achieve, it shouldn't need discussion.

A *pleasant manner* is second in demand, and goes with neatness. The idea is to make a good impression on the customer. Courtesy, politeness, consideration—everything that contributes to a good impression is a plus for the technician, and shop owners pay more to keep those pluses working for them.

Competence wasn't mentioned quite as often, but is related to the lack of adequate training. Shop owners have stories of job-hunters who truly believe they *are* good technicians, yet who simply can't face any but the most elementary TV servicing problems.



"...if you don't charge enough, you can't pay a good wage..."

If you're a radio/TV technician who hasn't made the grade, your only hope is to face whatever technical shortcomings you have and set about correcting them. If you don't really know what they are, there's still hope; you can take an exam.

A good examination is conducted by the National Electronic Associations, 5302 West 10th Street, Indianapolis, Indiana 46224. This organization has developed a voluntary certification program for service technicians. The certification exam, which is given for a very small fee, will show in what respect your technical knowledge is lacking, if it is. If you're interested, drop N.E.A. a note asking where and when you can take the exam. The certificate you get when you pass doesn't open a lot of doors, but it does show proof of technical knowledge.

Once you are aware of your weaknesses, and if you want to move up that wage ladder, you simply have to begin studying. Home study courses, seminars sponsored by manufacturers, distributors, and associations, resident technical schools, and even books on the subject can help you fill the gaps. The technician who doesn't catch up and keep up is doomed to low wages.

Most of the respondents to our survey were pretty specific about the areas of training they feel are most neglected among TV technicians. The shortage of competent service technicians for transistorized equipment (radio receivers, hi-fi, TV receivers) is acute. Shop owners and service companies pay "top dollar" for men who can repair these devices *properly*. The same is true for color TV receivers, which have grown in numbers faster than men can be hired to install them and keep them running.

The Service Charge. Simple arithmetic proves that a radio/TV repair shop that doesn't charge enough can't pay a good wage. To illustrate this point, we tabulated our analysis of service call charges by region (Table 3) and by population (Table 4).

Again, the most significant information comes from the breakdown by population. Average service charges increase directly with the size of the city. Also, service charges are higher for color than for monochrome receivers. The paradox

TABLE 3: TV SERVICE CALL CHARGES BY REGION						
REGION	MONOCHROME			COLOR		
	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW
WEST	12.95	8.75	2.50	15.00	10.75	5.00
CENTRAL	10.95	7.50	3.00	12.95	9.25	4.95
EAST	7.95	5.50	4.00	12.50	7.75	4.00

TABLE 4: TV SERVICE CALL CHARGES BY POPULATION GROUP						
POPULATION GROUP	MONOCHROME			COLOR		
	HIGH	AVERAGE	LOW	HIGH	AVERAGE	LOW
UNDER 50,000	9.50	6.00	3.00	12.50	8.25	6.00
50,000 TO 250,000	6.95	6.75	3.00	12.95	9.00	4.00
250,000 TO 1 MILLION	11.50	7.50	4.00	15.00	9.50	5.00
OVER 1 MILLION	12.95	8.00	3.00	14.95	10.00	4.95

is that in the "over-a-million" cities there are lower salaries, yet the average service charge is higher. The answer is simply that the overhead of a large-city TV service shop is frequently double small-town overhead.

Cheap service calls tell a sad story. A TV service shop that only asks $3 for a service call is in no position to pay its employees a satisfactory wage.* By and large, service charges for TV repair are substantially lower than charges for servicemen repairing dishwashers, washing machines, refrigerators, etc., and many responsible TV repair shop owners seemingly fail to realize that service charges can be increased without adversely affecting business volume.

For example, a small California service company reported that about three years ago it paid its technicians $2.50 an hour and that the maximum for color TV service house calls was $7.50. The overhead of the shop always kept profits virtually non-existent. The shop owner —because his back was to the wall—increased his charges across the board, and was astonished to find that there was no change in the number of his customers.

Six months later, this shop owner increased the charges another $2 and gave all of his technicians a whopping big raise. Two years ago, monochrome TV repair charges went to $10 and color TV calls to $12.50. The volume of business not only didn't decline, it increased; and there was another boost in wages.

In 1967 the charges went up again—reaching $12.95 for monochrome and $15 for color TV receivers. Business continued to boom, and the shop owner has found that his employees are happier, and—presumably because of the increased salaries—are giving the customers better service. This shop owner has halted the brain drain and is now enlarging fringe benefits to compare favorably with those of some of the biggest electronics manufacturers in the area.

Even if the TV servicing industry must pull itself upright by its own boot straps, it's time for the shop owners at the low end of the scale to realize that it is in their best interest to pay their technicians a living wage. —30—

*The tables do not reflect the few TV service shops that work without asking for a service charge. Just how these few shops can "legitimately" pay their TV service technicians any reasonable salary is open to speculation.

"He's a good worker. I'd promote him right now if he had more education in electronics."

Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

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INFORMATION CENTRAL

By CHARLES J. SCHAUERS, W6QLV

An often-asked question is: "Should I replace the vacuum-tube rectifiers in my equipment with solid-state (silicon) diodes?" In many cases, readers request specific design data for the updating of a particular unit, but this is not always readily available.

The advantages of using silicon diodes are: much less or no heat generation; higher output voltage (which may be a disadvantage in some instances where regulation is a problem); little noise generation, as compared to mercury vapor tube types; no filament transformer requirement, as for tube rectifiers; and long life. In original equipment, less mounting space is required for a power supply using silicon diodes.

Silicon diodes are now available with high peak inverse voltage (PIV) and current ratings; but where the higher voltages and currents are encountered, it is usually necessary to operate two or more diodes in series. These diodes should always have shunt resistance across them (for proper voltage distribution) and shunt capacitors (for transient voltage protection).

The shunt resistance is calculated from: $R = \frac{1}{2}(V_R/I_R)$ where V_R is the d.c. reverse rating and I_R is the d.c. leakage current of the diode. Shunt capacitors should have a capacitance of at least 100 or more times that exhibited by the diodes used; usually, this capacitance will range from 0.01 to 0.03-μF, and the final value is not critical as long as it exceeds the diode capacitance by the amount stated.

If diodes with marginal current ratings are employed, they should be heat-sunk using commercially available heat sinks or a metal area at least 40 times larger than each individual diode.

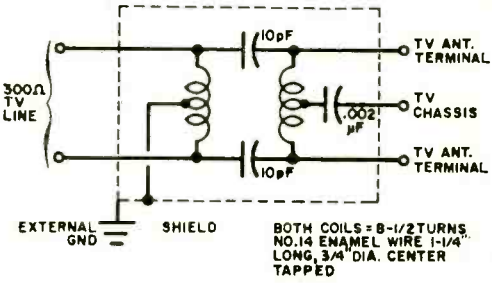
Silicon plug-in replacements are now available on the market for some of the most popular tube types, such as the 5R4GY, 5U4, 5Z3, 5AU4, 6AX5, 6X5, 866, 83, etc. They are relatively inexpensive and are properly rated. We advocate buying the commercial replacements rather than wiring in your own.

Tone Arm Characteristics. *What are the characteristics of a good tone arm?*

A good tone arm should have high tracking accuracy, stable balance, low resonance, and should operate with minimum friction.

CB TVI. *I just completed the installation of my CB base station. My signals interfere with our own TV sets but not the neighbors' sets. What can I do?*

First try a high-pass filter at each of your TV sets. A simple but effective one is shown below. Or you can buy a ready-made one. If



the high-pass filter does not work, then you may need to install a low-pass filter at your transceiver.

Q-Multiplier for S-38 Receiver? *Would a Q-multiplier improve the operation of my Hallicrafters Model S-38 short-wave receiver?*

It would help you separate stations better by increasing selectivity but would do nothing for the r.f. gain of the set. If you use a transistorized multiplier, you need not worry about adding a filament transformer, but you will have to if you buy (or build) a tube device. The S-38 is an a.c.-d.c. set and has no power transformer.

Squelch on CB-20 Transceiver. *The squelch on my Hallicrafters CB-20 transceiver stopped functioning. What should I check?*

Check *Q9*, the squelch gate transistor, and its associated components. Then check *CR-3*, the diode associated with transistor *Q4*. Suspect *C47*, the 5-μF, 10-volt capacitor (from base to ground of *Q9*).

Coax Vs. Open Wire. *I must locate my CB antenna about 250 feet away from the operating position. Should I use coaxial cable or open wire transmission line?*

I suggest the open wire line if it can be installed and properly matched to your set. You may have to use a balun (depending on

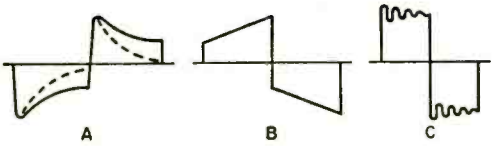
the antenna used). If you have a good antenna tuning unit, you will have no problem. Contrary to what some technicians think, the open wire line can handle higher voltages than coax, has lower loss at very high voltage-standing-wave ratios, and can also be used as a quarter-wave impedance transformer.

Volume in GR-64 Receiver. *I have a Heath GR-64 short-wave receiver which jumps to full volume. I replaced the 12AQ5 tube and cleaned the volume control with no results. What else can I do?*

Check all tubes first. Next, make sure that *all* interstage coupling capacitors are good—this can be done by bridging each capacitor with a good one. Finally, suspect the a.v.c. circuit. A resistor (especially the high valued ones) can change resistance and result in unusual volume changes.

Square Waves. *Is an ideal (absolutely square) wave attainable electronically? Using the best square wave obtainable and feeding it into an amplifier, what will the wave look like when (a) there is marked attenuation on low frequencies; (b) there is a boost of low frequencies; and (c) there is ringing?*

The answer to your first question is, generally, no. Even with the most elaborate electronic circuitry, the production of a perfect square wave is very difficult to achieve. Shown here are the square-waveforms for the three conditions you mention.



Soldering IC's. *I have purchased a number of integrated circuit modules for experimentation. When I received them, I was amazed at how small they were. How do I solder the terminals of the IC's? They are so small that even the smallest soldering iron cannot be used.*

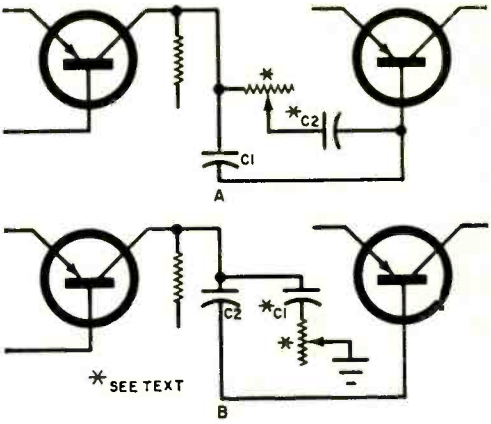
Most IC's are manufactured for circuit board mounting. These boards all have the necessary holes through which the IC terminals are placed. Granted, the soldering job even on boards is tricky, but it can be done with a small pencil iron.

2N241 Substitute. *What transistor types can I use in place of the 2N241?*

Try any of the following: 2N241A, 2N395, 2N396A, 2N397, 2N414, 2N414A, HEP254, GE-2, or SK3004.

Transistor Tone Controls. *How does one add a treble or a bass tone control to a transistorized audio amplifier circuit? I realize that the components used no doubt will depend upon stage gain, input and output impedances, etc., so no values need be mentioned—just the method of connection.*

The two diagrams below will give you an idea of how tone controls can be added to a.f. transistor circuitry. Circuit (a) shows a bass attenuation circuit and (b) a treble attenuation circuit. In circuit (a), the value of coupling capacitor *C1* is made much smaller than normal, and *C2*'s value can range from 1 to 25 μF. The potentiometer value can vary from 2000 to 25,000 ohms. In circuit (b), *C2* is the normal value, but *C1*'s value can range from 0.02 to 1 μF. The potentiometer for circuit (b) can be in the 3000- to 75,000-ohm range.



Antenna Loading. *My ham club is experimenting with radio-controlled rockets. The antenna we have to use for a frequency of 27.255 MHz can only be 8 inches long. What can be done to load this antenna properly?*

Use a loading coil that will make the antenna resonate at the desired frequency. However, the efficiency of such a short antenna will probably be very low. Also, you must have a Class C license for R/C experiments, unless power is below 100 mW.

HA-230 Receiver With Filter. *I recently purchased a used Lafayette HA-230 receiver, in which the person who owned it before me installed a mechanical filter. The receiver sounds muffled and bassy. What can I do about it?*

After the installation of a mechanical filter in any set, the i.f.'s should be repeaked to provide proper bandwidth. Also, when installing a mechanical filter, it is necessary to make certain that the filter selected is properly matched (impedance-wise) to both

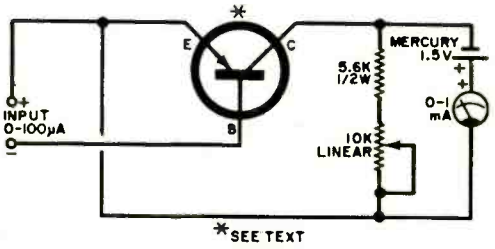
input and output i.f. circuits. Defective coupling capacitors, or capacitors that are too high-valued between i.f. stages, can create the muffled and bassy sound. Check the screen and cathode bypass capacitors as well.

Monitor Receiver Noise. *I monitor the 33.82-MHz frequency (our fire station) but I receive a lot of interference from traffic on a nearby freeway. What can I do to eliminate or attenuate the noise?*

Very little, if your set has no squelch circuit. (You could install the squelch circuit presented in this column in the February, 1968, issue, page 70.) Raising your antenna (fed with coaxial cable) may help, or even changing from a dipole antenna to a vertical may attenuate the noise. However, properly adjusted squelch will permit noise-free listening until your station comes on, and if the signal is loud enough, it will override the noise.

Milliammeter To Microammeter? *I need a 0-100 microammeter, but I find that it is more expensive than, say, a 0-1 milliammeter. I have several of the latter. Is there any way to modify an 0-1 mA meter for 100-microampere operation?*

No, but by using the circuit shown below you can convert an 0-1 mA meter to a linearly reading 0-100 microammeter. The



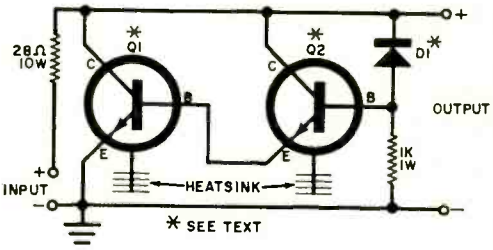
10,000-ohm potentiometer is adjusted for transistor gain variation. Beginning with a few divisions above zero, the accuracy of the microammeter will be close to 3% if the milliammeter is a 2% unit. Transistor types that can be used are: 2N408, 2N109, 2N270, or 2N407.

Contact Cleaners. *I have an old VTVM whose switches have all turned black. I know that this is one reason why the unit does not operate properly. What should I use to clean these switches?*

There are a large number of contact cleaners on the market and all seem to work very well. I suggest that you try "Contact Re-Nu" (MS-230), available from most radio distributors. For a thorough cleaning job, spray on the chemical and then use a brush. A number of applications may be necessary.

Voltage Regulator. *I need a voltage regulator that will handle a 45- to 55-volt input with an output of 28 volts at 0.5 ampere. The regulation should be good, at least 0.5%. I want to use transistors—not tubes. Can you help me?*

See the diagram below. Transistors that can be used are: the 2N1485 or 2N1486 for



Q1, and the 2N1481 or 2N1482 for *Q2*. Diode *D1* can be any reference diode rated at 27 volts at 1 ampere or higher—a typical one would be the 1N2954, which has a tolerance of 5%.

Dimmer Noise. *We have just built a house employing dimmer switches for the lights. When they are turned on, a loud roaring blast comes from the AM radio. The buzz is loudest when the switches are in their mid-position. What can be done?*

Coaxial capacitors in series with the line are a *must* if you want clear reception.

Relay Delay. *I own a popular transceiver and on CW and SSB the relay "hangs." How can I cure this condition?*

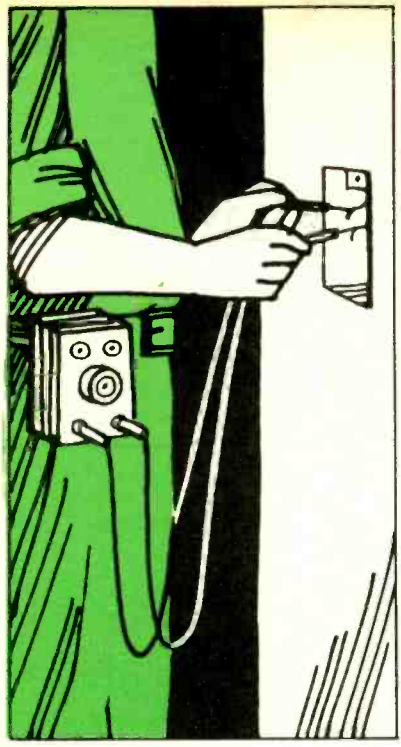
What transceiver? When a relay "refuses" to open up, the cause is usually a poorly designed RC holding circuit or too much capacitance across the relay. Try reducing the capacitance; this *will* alter the time constant.

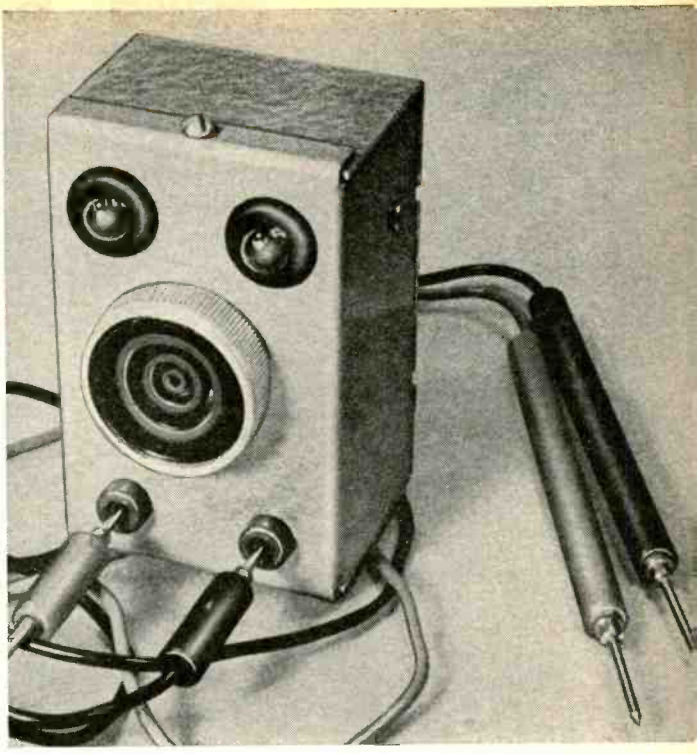
High-Low Voltmeters. *If I connect two voltmeters across a circuit, one being a 20,000-ohm-per-volt unit and the other a 5000-ohm-per-volt unit, will both meters indicate the same value?*

It depends on the circuit being measured. If circuit resistance is very low, then both meters will read approximately the same. However, if the circuit resistance is high, neither of them will indicate the correct value as the combined parallel resistance will be too low.

7A8 Tube Wanted. *I am having trouble obtaining a 7A8 tube. Can you suggest a possible source for this and other old type tubes?*

Perhaps the Arcturus Electronics Corp., 502 22nd St., Union City, N.J. 07087 can help you. -30-





"SonCon" Continuity Tester

Electrician's Helper You Can't Blow Out

by Neil Johnson, W2OLU

SOONER OR LATER it's bound to happen. You will be making a continuity test of an inoperative electrical appliance using your trusty old ohmmeter, when suddenly you will accidentally place the test probes of the ohmmeter across the power line. Poof, there goes the meter. The story gets even sadder when you have to fork over twenty bucks or so either for a new meter movement or a new VOM.

So, if you do any appliance testing, it will be worth your while to build the "Solid-State Continuity Tester." Not only will you get an audible indication of continuity (which means that you won't have to take your eyes off the job to look at a meter), but if you should accidentally place the probes across the power line, the tester will not be damaged.

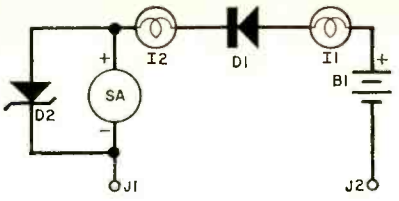


Fig. 1. SonCon circuit is a modern, burn out-proof version of the old-fashioned tester.

PARTS LIST

B1—9-volt battery
D1—Silicon rectifier, 1 ampere, 400 PIV
D2—Zener diode, 20 to 28 volts, 10 watts
I1, I2—Pilot lamp, 28 volts, tungsten filament (Type 313)
J1, J2—Banana jack
SA—Mallory "Sonalert" audible warning device, 6-28 volts d.c.
Misc.—Cabinet, test leads, grommets for lamp support, hookup wire, etc.

The continuity tester consists of a 9-volt battery in series with a "Sonalert" module. This module is a commercially available electroacoustic device which emits a shrill audio tone when its electrical contacts are supplied with from 6 to 28 volts d.c. The power line protective circuit consists of a pair of pilot lamps, a silicon rectifier diode, and a zener diode arranged in the circuit as shown in Fig. 1.

Some alert readers will recognize the similarity of this device to an old-fashioned buzzer-battery tester. However, a buzzer circuit requires about 75 mA to start operating, and any slight resistance in the circuit under test will prevent the buzzer from sounding. Furthermore, the sparks produced by an operating buzzer are a source of annoying radio-frequency interference (RFI), not to mention the possibility of an explosion if the device is operated within a gas-filled area.

The "Solid-State Continuity Tester," on the other hand, requires only 4 to 5 mA to operate, allowing the testing of even long, relatively high resistance lines (up to 1000 ohms). It has no moving parts to produce a spark (thus, no RFI), and its 2500-Hz tone is distinctive enough to be heard over most ambient noise.

If you should accidentally connect the test leads across the power line, imposing 117 volts a.c. across the input, the two pilot lamps will glow brightly, and the 2500-Hz tone will be modulated by the 60-Hz power line frequency—producing both a distinctive visual and audible alarm. Because the pilot lamps are tungsten filament types, they display a positive temperature coefficient of resistance; that is, the greater the current flow, the higher their resistance. This increased resistance lowers the voltage applied across the tone-generating module, and a zener diode connected directly across the module makes sure that the voltage breakdown of the module is not exceeded.

The complete circuit is constructed within a 2"-wide, 3⅜"-long, and 1½"-deep metal box, as shown in Fig. 2. Parts

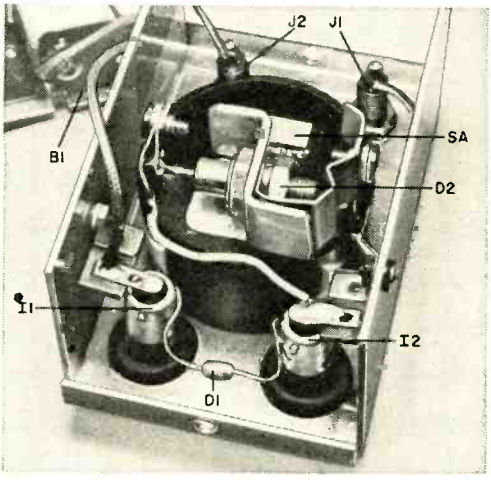


Fig. 2. Although the parts layout inside the metal box is not critical, the author suggests an arrangement similar to this. Note heat sink in zener diode.

layout is unimportant, but do NOT use the metal chassis as a common tie point. The author affixed a belt clamp to the rear of the box so that he could carry the tester clamped to his belt, leaving both hands free to manipulate the test leads.

The audible warning device is affixed to the front cover, and a pair of ⅜" rubber grommets support the two pilot lamps. The battery is strapped to the rear cover, and two test banana jacks are located at the front. —30—

Capacitor Circuit Quiz

BY ROBERT P. BALIN

Capacitors are not only used as single units in electronic circuits, but are often combined in series or parallel with other capacitors. When connected in series, capacitors add like resistors in parallel. The exact formula for adding any two out of any number of capacitors in series is: $C_T = C1 \times C2/C1 + C2$. When connected in parallel, capacitors add like resistors in series, so that the total capacitance is equal to the sum of the separate values. To test your skill at working capacitor problems, try to find the total effective capacitance available in each of the circuits (1-10) shown below. Each capacitor is rated at 6 pF. Hint: beware of capacitors that might be shorted out.

(Answers appear on page 86)

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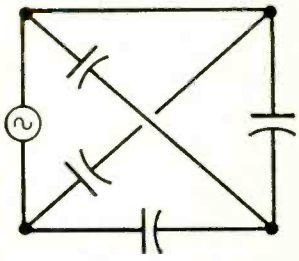

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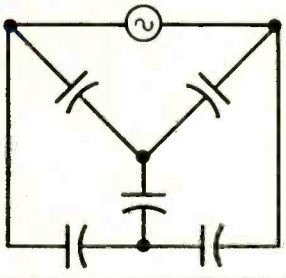

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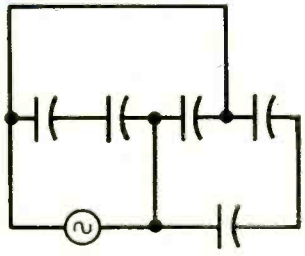

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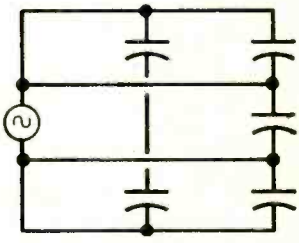

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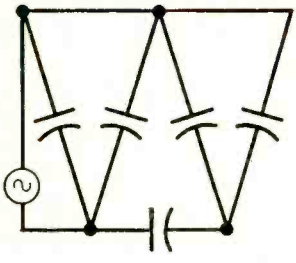

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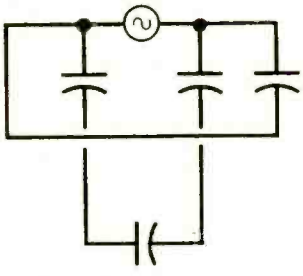

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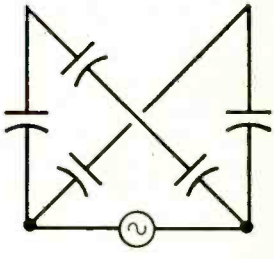

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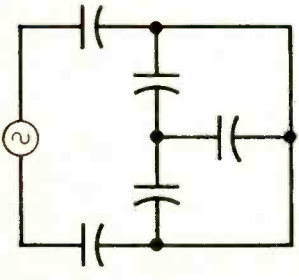

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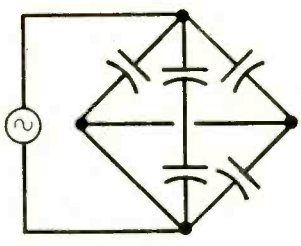

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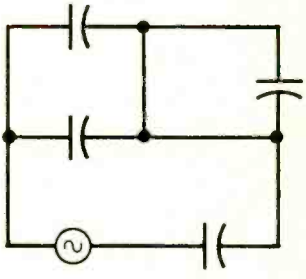


the product gallery

REVIEWS AND COMMENTARY ON ELECTRONIC GEAR AND COMPONENTS

WIRELESS FM AND AM MIKE KITS (EICO EC-1100 and EC-1200)

Electronic kit-building has in recent years become a national pasttime. As the variety in types of kits continues to increase, there seems to be a proportionally greater number of people buying and building them. There are, in fact, so many different types of kits on the market now that no matter what your professional or hobby interest is, there is undoubtedly one or more suitable for your purposes. There are such things as electronic burglar and fire alarms, tremolos, metronomes, wireless microphones, and bongos available in kit form at reasonable prices.

In the general interest group of electronic kits, you'll find the Eicocraft (made by EICO Electronic Instrument Company, Inc., 283 Malta St., Brooklyn, N.Y. 11207) Model EC-1100 FM wireless microphone and Model EC-1200 AM wireless microphone. Both kits are solid-state, and they sell for $9.95 each.

The FM wireless microphone is designed to transmit in the FM broadcast band (88-108 MHz), while the AM mike is tuned to the AM broadcast band (550-1500 kHz). Transmission distance will normally be about 50 feet maximum, but if a very sensitive receiver is used, the distance can be increased to about 100 feet. Tuning of the FM mike is accomplished by varying the setting of a trimmer capacitor. In the AM mike, tuning is accomplished by adjusting a powdered iron-core coil. First tune your receiver to a "silent" spot on the dial, then tune the mike until you hear your voice over the receiver.

Construction of the individual kits is simple and straightforward—even if you've never assembled a kit before. All parts except the batteries and microphone transducers (and, in the case of the AM mike, tuning coil) mount directly on a compact printed circuit board. Once a board is wired (it takes about one hour) and the microphone and battery are installed, the entire circuit is housed inside a metal case slightly larger than a pack of cigarettes which weighs only a few ounces. The individual units are so small, in fact, that each will fit in a shirt pocket.

Circle No. 86 on Reader Service Page 15 or 95

HIGH-SENSITIVITY VOM (Lafayette 99-5076)

That old standby test instrument—the VOM multitester—has been with us for many years, and will probably continue to be of service until the 21st century. While some multitesters are going solid-state, other VOM's are making the most of new low-cost, very accurate, and sturdy meter movements. The Lafayette Radio Electronics (111 Jericho Turnpike, Syosset, L.I., N.Y. 11791) Model 99-5076 "Lab-Tester" is a prime example of a low-cost VOM ($19.95) with a remarkably high input sensitivity (50,000 ohms-per-volt).

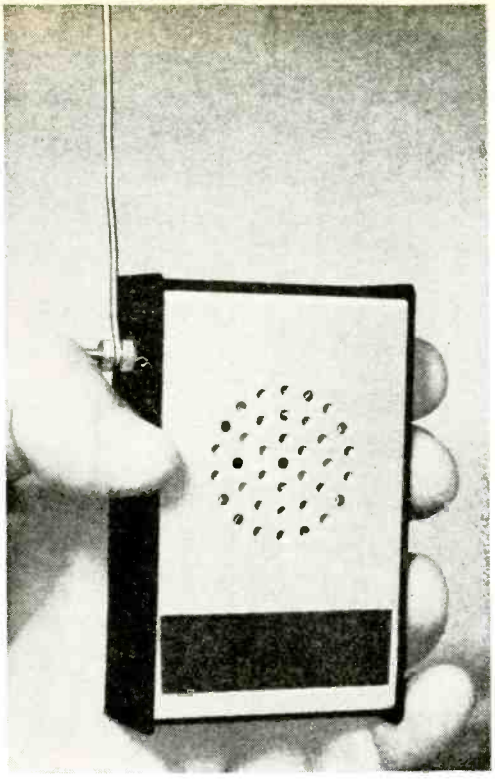
POPULAR ELECTRONICS recently had the opportunity to use the Model 99-5076 for a few weeks. Since many of our published projects involve solid-state circuits, we were particularly impressed with the low-voltage d.c. full-scale range of 0.125 volt and the a.c. range of 1.5 volts—the latter at 5000 ohms-per-volt. Top range of the 99-5076 is 1000 volts d.c. and a.c. The critical resistance measuring ranges work out at 13, 65, 650, 6500, and 65,000 ohms at center scale.

Your reviewer was also pleased (and surprised) to find that this VOM had a panel-mounted polarity reversal switch. If you're still using one of those antique VOM's which does not incorporate a reversal switch, you'll discover that this feature will save you many minutes of frustrating lead switching.

The Model 99-5076 has a large, easily read meter scale, and the ranges are changed by means of a rotary switch on the right-hand side of the VOM. An identical knob on the left-hand side of the VOM is for ohmmeter zero set. The handle swivels over the top of the VOM so that it is tilted on the bench.

The 99-5076 is imported from Japan and seems to be a rugged multitester capable of withstanding the normal amount of workbench abuse. The manufacturer claims that the meter movement (20 μA) is shielded. Our in-use tests clearly indicated a fair amount of needle damping. Unquestionably, the 99-5076 is a very good buy, and maybe you had better snap one up before someone at Lafayette realizes that the darn thing is badly underpriced.

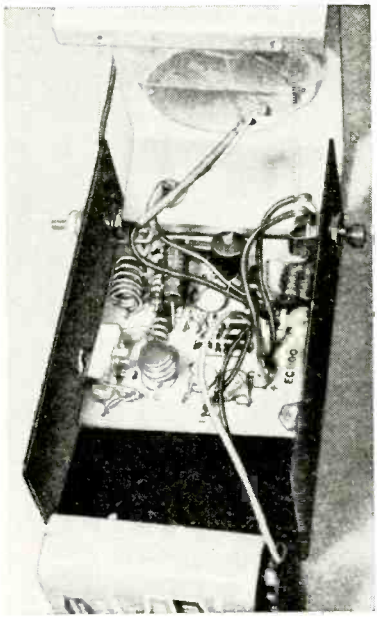
Circle No. 87 on Reader Service Page 15



EICOCRAFT

FM AND AM WIRELESS MIKES

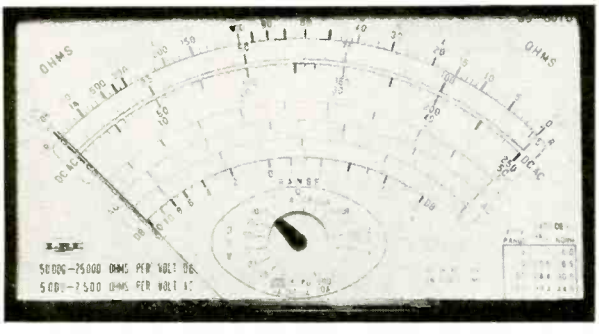
Functional palm-size metal cases used to house the individual mikes (left) are identical. Front, top, and bottom of the cases are finished in brushed aluminum; sides and rear are black. Inside, the mikes are compact (below), and all parts are easily accessible from the top of the printed circuit board.

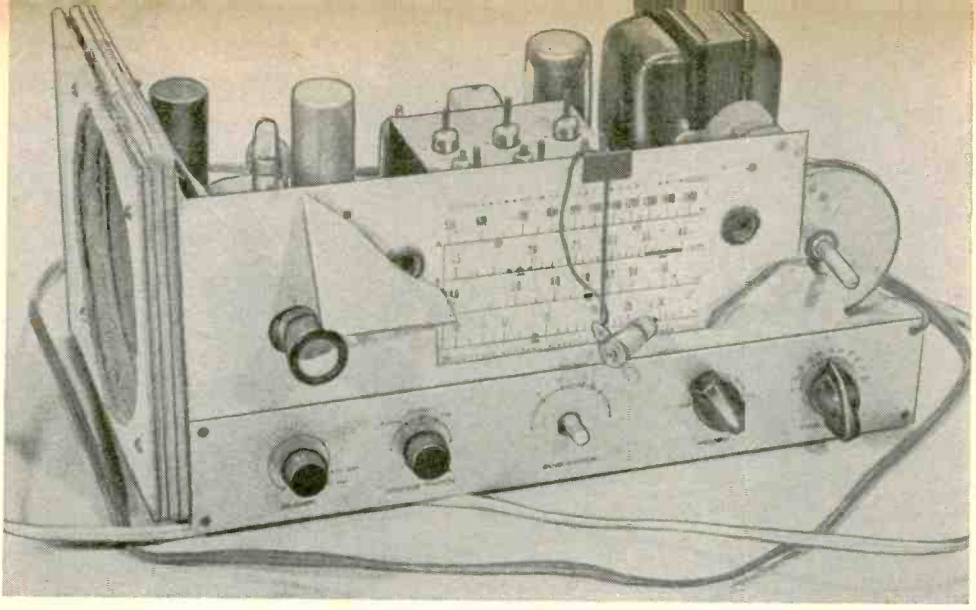


LAFAYETTE

HIGH-IMPEDANCE MODERN VOM

The range-indicator "clock dial" located just below the "Lab-Tester's" meter pointer (below) gives the front panel an extra-clean appearance. As the range switch is rotated, the dial pointer indicates the a.c. range (printed in red) or d.c. range (printed in black) being used. The carrying handle swings back to support the meter at a convenient viewing angle. The range switch and ohms-zero controls are located on opposite sides of the case.



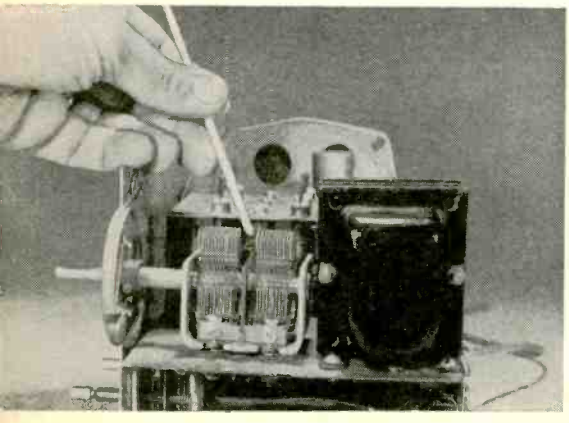


CLEANING UP A CLUNKER

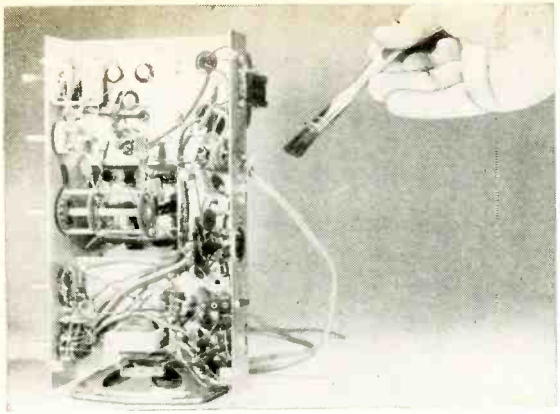
Why not devote a few hours to sorting and cleaning out your "junk box"?

by Marshall Lincoln

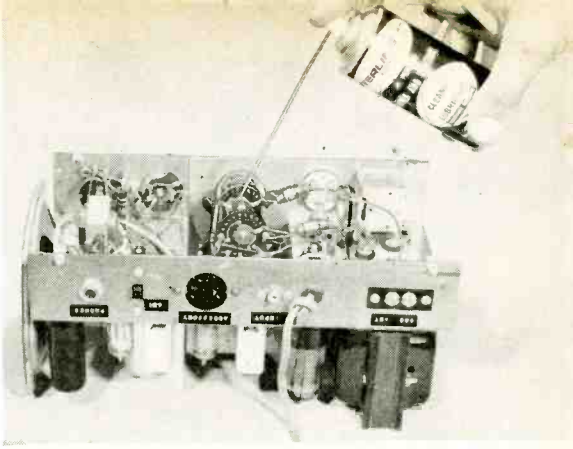
To avoid bending the plates of variable air-spaced capacitors, clean between the plates with an ordinary pipe cleaner wetted down with carbon tet or alcohol. The pipe cleaner also comes in handy when you have to clean areas inaccessible to a brush.



Tears in speaker cones can be quickly repaired with nail enamel or airplane glue. Before applying the enamel or glue, make sure the cone surface is free of dust. If a second application is needed, allow the first coat to dry for at least 30 minutes.



Restoration begins with a thorough cleaning of the chassis, using a small brush and/or vacuum cleaner. Stubborn dirt, grease, and capacitor electrolyte are easily removed with carbon tetrachloride—pitch with kerosene or benzene. While cleaning the chassis, be on the lookout for heat-scarred and broken components, frayed wires, and cold solder connections.



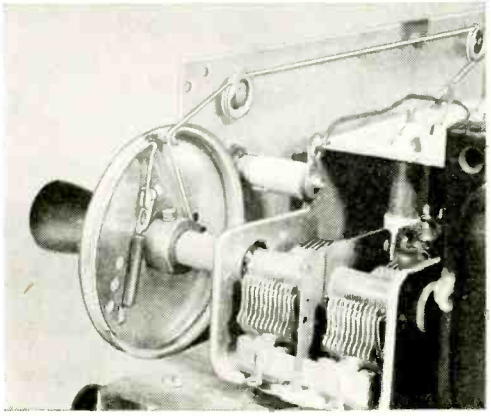
The next step is to remove oxide scale from switch contacts and dirt from inside potentiometers. This can be accomplished by spraying a good quality contact or pot cleaner into the respective devices and rotating the shafts several times to make sure good electrical contact is obtained. Repeat this process several times to obtain desired results.

DO YOU HAVE any old pieces of electronic gear gathering dust in your workshop simply because they were superseded by newer models or need minor repairs? If your hobby is electronics, odds on a YES answer are very good. And if your answer is yes, why not take a few hours to restore that old communications receiver, table radio, or what have you, to working order? The job isn't as difficult as it may seem, and with a few new parts those relics might perform better than they did when new.

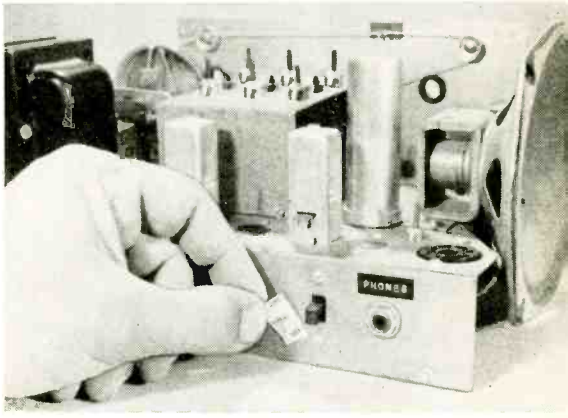
Some of the units in your "junk box" can be salvaged and given away to neighborhood kids interested in electronics. Some have potential uses for tuning to time signals, or being converted to a simple p.a. or intercom system. And you might have a few that can be sold.

Once committed to "cleaning up a clunker," don't be surprised if you won't want to stop until the job is done. At least, if you can't salvage a particular piece of equipment, you'll be able to "junk" it with a clear conscience. —30—

If a dial cord shows signs of fraying or wear, remove it and carefully measure its length. Use an oil-reducing solvent to clean the tuning control wheel, and oil only the axes of the dial cord pulleys. Restring the dial, using new cord and a new spring.



Finally, remove and replace worn or broken parts and frayed wiring, and resolder any connections that appear to be doubtful. For a neat, professional appearance, label all external controls and jacks. Then, if necessary, align the unit at your workbench.



SOLID STATE

By LOU GARNER, Semiconductor Editor

TWENTY YEARS AGO, reporters, editors, columnists, and other members of the press were invited to a special conference at the West Street Headquarters of the Bell Telephone Laboratories in New York City. At the meeting, which turned out to be an historic one, Bell Laboratory representatives described and demonstrated a new type of electrical component—a three-electrode device which had the ability to provide a net signal gain. Appropriately, the device was identified as a *trans*fer re*sistor* and dubbed, in short, a *transistor*.

The fascinating story behind this far-reaching solid-state development will be found in the article, "The Quest for the Crystal That Amplifies," starting on page 40 of this issue.

Readers' Circuits. Nearly one-third of the experimental circuits submitted by readers these days fall into the "home broadcaster" category. The home broadcaster (or wireless microphone) has displaced the basic one- or two-transistor receiver as the most popular simple project among experimenters. Perhaps this is not too surprising when we consider that a variety of multi-transistor receivers are available for only a few dollars through many supermarkets, drug chains, discount outlets, and appliance stores. This month, then, we are featuring three typical circuit designs, submitted by as many readers. All three are limited range units intended for operation within the AM broadcast band.

Steve Trosper, of Perrysville, Indiana, contributed the circuit in Fig. 1. He writes that the design was adapted from an earlier circuit suggested by reader Gerry S. Franklin and described in the August, 1965, column.

The circuit is essentially a common-base modified Colpitts-type oscillator. Conventional ferrite loopstick *L1* is tuned within the AM broadcast band by *C1* and distributed circuit capacities. Capacitor *C2* forms part of a capacitive voltage-divider which provides the feedback needed to start and maintain oscillation. Base bias is established through an adjustable series resistor, *R1*, bypassed by *C3*, while audio modulation is introduced in the emitter circuit by a carbon microphone. Operating power is furnished by *B1* (15 volts), bypassed by *C4*, and controlled by switch *S1*.

Steve used conventional parts in his design, with *Q1* a general-purpose *pnp* transistor. He tried a 2N107 transistor in his first model, but ended up with a bargain type from a "surprise" package assortment.

Dubbed a "TV Sound Transmitter" by its contributor, George Girod (159 W. Mill St., Winona, Minn. 55987), the circuit in Fig. 2 is intended for a special application—the rebroadcast of TV audio program material to conventional AM receivers. It uses a TV

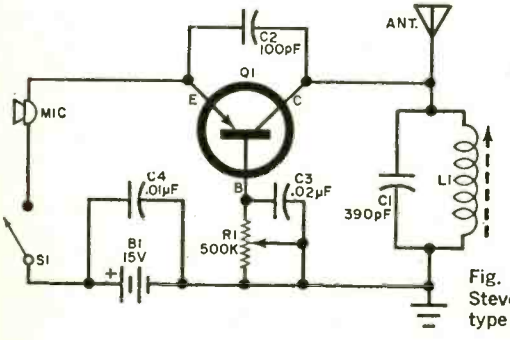


Fig. 1. The BCB circuit submitted by Steve Trosper is a common-base Colpitts-type oscillator, modulated by a carbon mike.

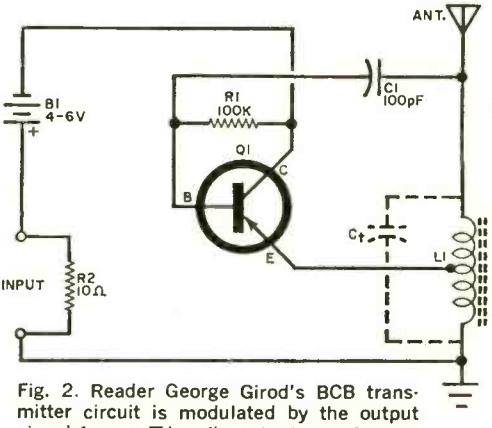


Fig. 2. Reader George Girod's BCB transmitter circuit is modulated by the output signal from a TV audio output transformer.

loudspeaker's voice-coil signal as its audio signal source.

George's circuit is a modified Hartley-type oscillator, with the feedback needed to sustain oscillation furnished by tapped coil *L1*. Base bias is supplied through *R1*, with *C1* serving as a d.c. blocking and coupling capacitor. Resistor *R2* is used as a substitute load in place of a speaker voice coil.

Again, conventional parts are used, with *Q1* an RCA SK3008 general replacement *pnp* transistor, *L1* a standard tapped oscillator coil for a broadcast-band receiver, and *C1* a small mica or ceramic capacitor. Tuning capacitor *Ct*, if used, can be a 350-pF variable. Although *R1* is a half-watt resistor, *R2* must be a 10-watt unit. Battery *B1* consists of three series-connected penlight or flashlight cells.

In operation, the unit's input terminals are connected to the secondary winding of a TV set's audio output transformer in place of the set's regular speaker voice coil. The TV volume control is adjusted for optimum audio as heard through a monitor (AM) receiver tuned to the transmitter's frequency.

George writes that he assembled his prototype model within a total volume of one cubic inch (not including batteries) by omitting a tuning capacitor (*Ct*) and relying on distributed wiring capacities for tuning. If desired, a carbon microphone cartridge can be substituted for the speaker drive—simply connect the microphone, bypassed by a 0.01-μF capacitor, in place of *R2*.

Reader Joseph Lawrence (Box 245, 6921 Security Wing, APO, San Francisco, Calif. 96210) submitted the circuit in Fig. 3. Essentially a base-modulated Colpitts oscillator, Joe's circuit employs a crystal microphone. Base bias is established by *R1*, bypassed by *C1*, in conjunction with emitter resistor *R2*. The feedback needed to maintain oscillation is provided by capacitive voltage-divider *C2-C3*, which also serves as a tuning capacitor across coil *L1*.

Joe writes that he used the upper coil from a standard 455-kHz i.f. transformer for *L1*, salvaging *C2* and *C3* from the same equipment. All three capacitors (including *C1*) are ceramic types, while *Q1* is an *npn* 2N1306.

Neither layout nor lead dress should be critical in any of the three circuits; hence, perforated board, point-to-point chassis wiring, or etched circuit construction techniques can be used for assembly, as preferred. Optimum results generally are obtained with relatively short antennas (one to three feet). Where bias controls are included, as with *R1* in Fig. 1 and *R2* in Fig. 3, these are adjusted for the best compromise between range and audio quality as heard on a monitor (AM) receiver. As with any "broadcaster," each individual frequency should be set for a dead spot (no local station) on the broadcast band.

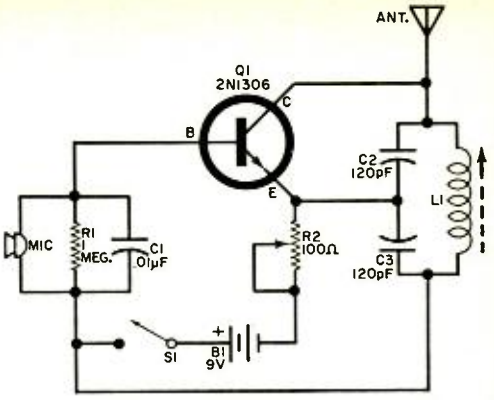


Fig. 3. Base-modulated Colpitts-type broadcast-band transmitter circuit from reader Joseph Lawrence uses an ordinary crystal mike as the audio source.

Manufacturer's Circuit. Abstracted from Vol. 5, No. 2, of the *Motorola Monitor* (published by Motorola Semiconductor Products, Inc., Box 955, Phoenix, Ariz. 85001), the 20-watt audio amplifier circuit in Fig. 4 is rated at 40 watts peak power, with a reasonably flat frequency response from d.c. to 20 kHz. Its specified harmonic and intermodulation distortion levels are less than 0.7% and 0.5%, respectively, at any power output from 0.1 to 20 watts. The circuit's efficiency is listed as 54% at rated output, with a dissipation of only 210 mW at zero signal input.

The Motorola design features an integrated circuit preamp/driver and a class-B complementary-symmetry, direct-coupled, push-pull power amplifier. Frequency compensation of the IC amplifier permits inclusion of the output stage in the feedback loop, while crossover distortion of the Class B stage is minimized by a parallel feedback capacitor (*C5*).

Naturally, Motorola parts are specified. The IC is a MC1433 integrated operational amplifier, while *Q1* is a 2N3904, *Q2* a 2N3906, *Q3* a 2N3791, and *Q4* a 2N3715. The resistors are half-watt, 10%-tolerance types, although 1-watt units may be preferred for *R6* and *R7*. The capacitors should be good quality, low-voltage ceramic types. *J1* is a phono or microphone jack.

Conventional construction methods can be used for assembling the circuit, provided good audio wiring practice is observed. That is, signal carrying leads should be kept short and direct, and adequate separation

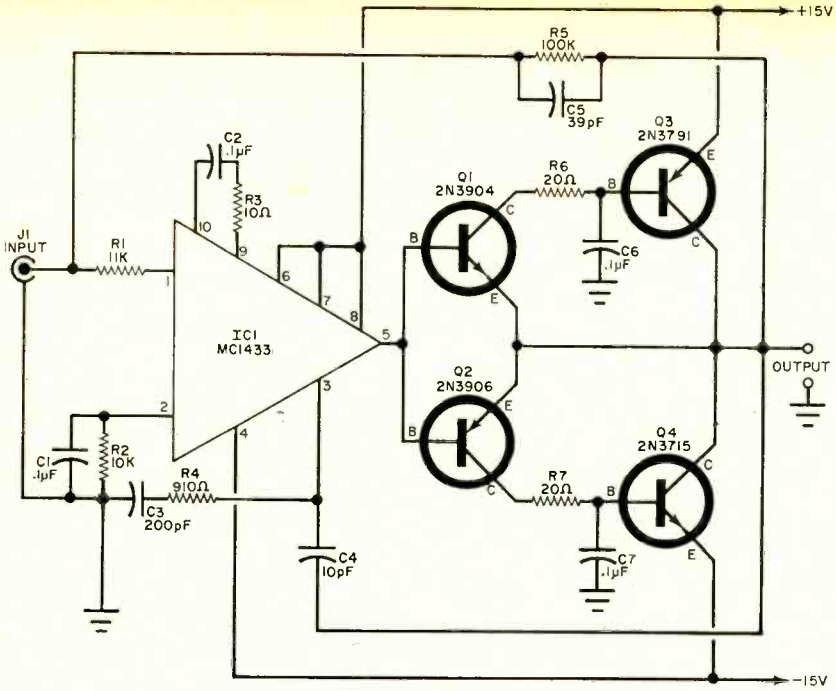


Fig. 4. Developed by Motorola, this 20-watt audio amplifier is a good example of the trend toward combining integrated circuits and discrete power output transistors.

insured between the input and output stages. Small insulated heat sinks are adequate for the drivers, *Q1* and *Q2*, but power transistor heat sinks should be provided for the output units, *Q3* and *Q4*.

The completed amplifier can be used with any hi-fi preamplifier equipped with loudness and tone controls which is capable of delivering a 1 volt (r.m.s.) signal to an 11,000-ohm load. For optimum performance, the d.c. power source should be a well-filtered, center-tapped 30-volt (±15 volts) d.c. supply with a minimum rating of at least 3 amperes.

In operation, maximum power output is achieved with a 4-ohm load. An 8-ohm load can be used, if necessary, but the r.m.s. power output will be reduced to approximately 12 watts.

Industry Items. Westinghouse is now producing a low-cost 1-watt IC audio amplifier. Netting for only $3.10 each in unit quantities, the WC-334AT is housed in an eight-lead TO-78 package. With an input impedance in excess of 300,000 ohms and an output impedance of only 0.3 ohm, the WC-334AT will accept direct coupling from a ceramic pickup and, in turn, can provide direct drive to an 8- or 16-ohm speaker voice coil. Requiring but 15 volts d.c. for operation, it has a nominal power gain rating of 65 dB and a frequency response from 50 Hz to 10 kHz.

A new addition to the GE PA-200 series of linear IC amplifiers has been announced by General Electric's Semiconductor Division. The new device, a 1-watt audio amplifier, contains a *pnp* and six *npn* transistors, three diodes, and several resistors. Although it is housed in a standard 8-pin package, it has only four active leads, and requires only six external components to assemble a complete audio amplifier section.

RCA has recently published a new and, in our opinion, extremely valuable book, a 200-page *Transistor Servicing Guide*. With individual chapters devoted to such topics as transistor amplifier principles, basic amplifier considerations, radio circuits, TV circuits, and servicing techniques, the new book, No. 1A1673, is being offered at only $3.50 a copy through franchised RCA tube and transistor distributor outlets.

Transitips. A transistor's high frequency (r.f.) characteristics may be specified in any of a number of different terms, depending on individual manufacturer preferences. Al-

(*Continued on page* 85)

SHORT-WAVE LISTENING

By **HANK BENNETT,** W2PNA/WPE2FT
Short-Wave Editor

MORE ON THE HIGH FREQUENCIES

THE short-wave broadcast activity currently taking place in the 26-MHz band was mentioned briefly last month. Since then several monitors have submitted reports on stations they have heard in that band. A partial listing of these reports is presented below to help you log a number of new stations.

This listing of definite frequencies will also make it possible for readers who so desire to make up a calibration chart covering this band for use with their receivers. The frequencies are given in kilohertz, times in GMT.

Bear in mind that these higher frequencies may not be used as regularly as the lower frequencies. You should, however, be able to log many of the following:

26,080 BBC, London, to Africa from 1315 to 1330 s/off
26,040 VOA, with Eng. news at 1315
25,900 *R. Norway*, ID in Eng. at 1300, then native language, to the Middle East; Eng. from 1600 to 1634 s/off
25,880 VOA, Tangier, with Eng. talks and music at 1245-1330

Robert Timm, WPE9JEB, of Two Rivers, Wis., is shown operating his Hallicrafters SX-130 receiver, which is augmented by a 100′ antenna. Bob's current record is 20 states, 3 countries verified.

Harry Okey, Jr., WPE6ETT, La Jolla, Calif., uses a Hammarlund HQ-170 receiver connected to a Mosley SWL-7 Trap dipole antenna. Primarily a ham radio DX'er, Harry has all 50 states verified.

25,790 *R. RSA*, Johannesburg, with pop music to Africa at 1250-1335, and at 1815 with "Music and Meditation"
25,750 BBC, London, in Thai at 1315, and in Eng. to Africa to 1745
25,730 *R. Norway*, in native language to N.A. from 1300
25,720 BBC, London, with "Radio Newsreel" in Eng. at 1200
25,670 BBC, London, in Arabic to Middle East at 1255
25,650 BBC, London, to Africa with "World Radio Club" at 1245; usual programming at 1535-1555
26,625 *Vatican Radio*, reported testing
25,610 *R. Nederland*, reported testing

According to the Zurich Observatory in Switzerland, the current peak of sunspot activity will occur about the time that you read these words. The sunspot average is expected to start dropping slowly in June to 116 and in July to 115. This will not result in a complete and sudden disruption of service on these bands, of course, but it does mean that the next 8-10 months will be the best time for listening.

DX Honor Roll. There have been two additions to the DX Honor Roll this past month. Mike Mandrick, WPE2GVF, of Rochester, N.Y., has 160 countries, 50 states,

(*Continued on page* 94)

ENGLISH-LANGUAGE BROADCASTS TO NORTH AMERICA FOR THE MONTH OF JUNE

Prepared by ROGER LEGGE

TO EASTERN AND CENTRAL NORTH AMERICA

TIME—EDT	STATION AND LOCATION	FREQUENCIES (MHz)
7 a.m.	Stockholm, Sweden	15.24
7:15 a.m.	Melbourne, Australia	9.58, 11.71
7:45 a.m.	Copenhagen, Denmark	15.165
8:15 a.m.	Montreal, Canada	9.625, 11.72
7 p.m.	Helsinki, Finland	15.155
	London, England	11.78, 15.26, 17.79
	Montreal, Canada	9.625, 11.945, 15.19
7:45 p.m.	Tokyo, Japan	15.135, 17.825
8 p.m.	Moscow, U.S.S.R.	9.665, 11.87, 15.15
	Sofia, Bulgaria	9.70
8:30 p.m.	Budapest, Hungary	9.833, 11.91, 15.16
	Johannesburg, South Africa	9.705, 11.875
	Kiev, U.S.S.R. (Mon., Thurs., Fri.)	9.665, 11.90, 15.15
	Stockholm, Sweden	11.805
8:50 p.m.	Vatican City	9.69, 11.76, 15.285
9 p.m.	Berlin, Germany	9.73, 15.17
	Havana, Cuba	9.525, 11.76
	London, England	9.58, 11.78, 15.26
	Madrid, Spain	6.13, 9.76
	Peking, China	15.06, 17.68, 17.90
	Prague, Czechoslovakia	7.345, 11.99, 15.365, 17.84
	Rome, Italy	11.81, 15.41
9:30 p.m.	Berne, Switzerland	9.535, 11.715, 15.305
	Bucharest, Rumania	11.94, 15.25
	Cologne, Germany	9.64, 11.945
	Hilversum, Holland	9.59 (Bonaire relay)
	Tirana, Albania	7.30
9:45 p.m.	Copenhagen, Denmark	9.52
10 p.m.	Cairo, Egypt	9.475
	Lisbon, Portugal	6.025, 9.68, 11.935
	Melbourne, Australia	15.32, 17.84
	Moscow, U.S.S.R.	9.665, 11.90, 15.15
	Stockholm, Sweden	11.805

TO WESTERN NORTH AMERICA

TIME—PDT	STATION AND LOCATION	FREQUENCIES (MHz)
8 a.m.	Tokyo, Japan	9.505
7 p.m.	Melbourne, Australia	15.32, 17.84
	Taipei, China	15.125, 15.345, 17.89
	Tokyo, Japan	15.135, 15.235, 17.825
7:30 p.m.	Johannesburg, South Africa	9.705, 11.875
8 p.m.	London, England	6.11, 9.58, 11.78
	Madrid, Spain	6.13, 9.76
	Peking, China	11.945, 15.095, 17.68
	Seoul, Korea	15.43
8:30 p.m.	Bonaire, Netherlands Antilles	11.82
	Prague, Czechoslovakia	7.345, 11.99, 15.365
	Stockholm, Sweden	11.705
8:45 p.m.	Berlin, Germany	15.17, 15.29
9 p.m.	Havana, Cuba	6.135, 9.525, 11.76
	Lisbon, Portugal	6.025, 9.68, 11.935
	Moscow, U.S.S.R. (via Khabarovsk)	15.18, 17.775, 17.88
	Peking, China	11.945, 15.095, 17.68
	Sofia, Bulgaria	9.70
9:15 p.m.	Bangkok, Thailand	11.91
9:30 p.m.	Bucharest, Rumania	11.94, 15.25
	Budapest, Hungary	9.833, 11.91, 15.16
	Kiev, U.S.S.R. (Mon., Thurs., Fri.)	9.665, 11.90, 15.15
9:45 p.m.	Berlin, Germany	15.17, 15.29
	Cologne, Germany	9.545, 11.945
10 p.m.	Havana, Cuba	6.135, 9.525, 11.76
	Tokyo, Japan	17.785
10:15 p.m.	Berne, Switzerland	9.71, 11.715
11 p.m.	Moscow, U.S.S.R. (via Khabarovsk)	15.18, 17.775, 17.88
11:30 p.m.	Havana, Cuba	9.655

ON THE CITIZENS BAND

By **MATT P. SPINELLO,** KHC2060, CB Editor

YOUR CB EDITOR'S reporting of on-the-air conditions in various parts of the country has been challenged, at least by one reader. The challenger is a resident of Arvada, Colorado, who feels that conditions on the Citizens Band in the area surrounding Denver, Colorado (reported on favorably in the February issue) are as bad as anywhere else in the country. He politely chewed us out for not presenting the facts—as he sees them.

MONITOUR TO UTAH

To set the record straight for all readers, our stopovers in any given area may range from a few hours to several days. The reports, gathered by actual on-the-air transmission monitoring and (usually) by discussions with area CB'ers, are not meant to confirm the pattern by which the 11-meter users conduct their transmissions on a year-round basis. We do feel, however, that a general idea of operating conditions can be determined from monitoring a minimum of 50 calls.

Actually, while we were in the Denver area, some 400 calls were monitored, and the lack of violations, plus the orderly use of channel 9, was impressive. Our Colorado complainer might better appreciate the CB air waves in his area if he had come along on our recent Monitour stop in Salt Lake City, Utah.

Well in advance of the trip, we forwarded a letter to the Utah Citizens Band Association. It was returned by the post office stamped "no box record." With no personal contacts in the area, we were left to draw our statistics from monitoring alone.

Approximately 60 calls were monitored over a two-day period. The following 12 calls exemplify a typical hour-long monitoring session; they are listed here in the order in which the calls were monitored.

(1) "Unit 1 to base . . . no copy! Unit 1 to Unit 6, you there? Unit 1 to base, no copy!"

(2) Business call; short, pert, to the point.

(3) Indiana skip to unidentified station: "How 'bout it, pussycat, do you copy 'Deputy Dog' in Indianapolis?"

(4) "New Mexico, do you copy Mississippi?"

1968 OTCB JAMBOREE CALENDAR

Planning a jamboree, get-together, banquet, or picnic? Send the details to: 1968 OTCB Jamboree Calendar, POPULAR ELECTRONICS, One Park Avenue, New York, N. Y. 10016. For more information on the jamborees listed below, contact the clubs or club representatives at the addresses given.

Middlesex, Vermont — **June 1-2**
Event: Third Annual Jamboree of Central Vermont. Location: Middlesex Campgrounds. Sponsor: Central Vermont CB Club, Inc.

Lockport, New York — **June 9**
Event: CB Jamboree. Location: Cinderella Park on Niagara Street. Sponsor: Western New York Pioneer Radio Association. Contact: Sue Isele, 2789 Quaker Rd., Gasport, N. Y. 14067

Lexington, Massachusetts — **June 16**
Event: CB Jamboree. Location: Suburbs of Boston, Mass. Sponsor: Paul Revere Emergency Radio Service. Contact: Robert Sweet, Secretary, P. O. Box 495, Lexington, Mass.

Greenville, Mississippi — **June 23-24**
Event: First Annual CB Jamboree. Location: Old Municipal Airport, Highway 82, East. Sponsor: Greenville CB Clubs. Contact: Jerry Sykes, 703 East Third St., Leland, Miss.

Dallastown, Pennsylvania — **June 29-30**
Event: Sixth Annual CB Jamboree. Location: Dallastown Lion's Club Park. Sponsor: York C.B. Assistance Club. Contact: Christopher Terrasi, 1968 Jamboree Chairman, 626 Ogontz St., York, Pa. 17403.

London, Ontario, Canada — **June 29-30**
Event: Campout '68, held in conjunction with London's Annual Fortnight Festival. Sponsor: South Western General Radio Association. Contact: Peter Harding, Campout '68 Chairman, 26 Grosvenor St., London, Ontario, Canada.

Warminster, Pennsylvania — **June 30**
Event: First CB Jamboree. Location: Willow Grove Amusement Park. Sponsor: Eastern Pennsylvania REACT, Inc. Contact: Eastern Pennsylvania Jamboree, Box 309, Warminster, Pa. 18974.

Louisville, Kentucky — **July 28**
Event: Third Annual Jamboree. Location: Funland Amusement Park. Sponsor: Iroquois Gentlemen CB Club. Contact: Ronald Zibart, 111 Juneau Dr., Middletown, Ky. 40043.

Lexington, North Carolina — **August 17-18**
Event: First CB Jamboree. Location: Davidson County Fairgrounds. Sponsor: Pioneer CB Club. Contact: Virginia Athay, 11 Hawthorne Lane, Lexington, N. C. 27292.

Enon Valley, Pennsylvania — **August 25**
Event: Seventh Annual CB Jamboree. Sponsor: Sociable 5 Watts, Inc. Contact: Roy Shelter, Enon Valley, Pa. 16120.

(5) Woman in Cincinnati frantically trying to reach skip station in California.

(6) Woman, without call-sign, identified other station as "Potato Bug."

(7) "C'mon back to the ole Bobcat, break, break!"

(8) Texas skip: "Just wanted to cut in to say 'hi'."

(9) More Texas skip.

(10) "Old White Bull" in Indiana talking to unidentified skip station.

(11) "This is the 'Old Yankee' in Central Indiana, break, break!"

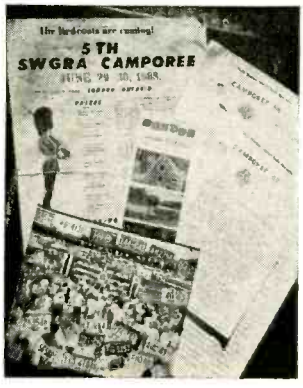
(12) Arkansas skip station attempting to contact "Wing-Ding" in California.

Note that out of the 12 successive calls only one was legal, and that one was a local Salt Lake City transmission. During other monitoring attempts in the Salt Lake City area, we found that channel 9 is apparently being used as the calling channel, and that calls placed locally are not to be compared with the skip transmissions.

Incidentally, those California operators who were apprehended by an FCC squad for their fun-'n-games tactics on the air, as previously reported, are in deeper and hotter water as of this writing. According to J. P. DeMoss, WB6CYO/WZ7BXM, Oakland, Calif., the FCC's Safety and Special Radio Services Bureau has levied nearly $2000 in fines. Individual fines ranged from $100 to $300, and Ney Landry, FCC Engineer-in-Charge, stated that several of the "jokesters" would lose their licenses.

Jamboree Beef-Up. If your CB club is still pondering whether or not to launch plans for this year's jamboree due to lack of attendance at last year's event, the promotional tactics of the South Western General Radio Association, London, Ontario, Canada, might be of interest to your planning committee.

The SWGRA promotion kit, directed to publication editors by National Publicity Chairman Gearald Inch, consists of a personal covering letter, a 2-page publicity release, and an 8 x 10 matt-finished photo of last year's event. The release covers the upcoming celebration in detail.



In answer to CB'ers who request information, SWGRA's "Camporee '68" Chairman Peter Harding forwards a 6-page letter covering this year's program in detail and an 11 x 17 4-page newspaper on last year's successful jamboree. Also included is a full-color brochure highlighting the places to visit while in the London, Ontario, area, details on highway routes to London from various points, a large map of the Camporee grounds, and a reservation sheet.

Club News. The Mobile Communications Emergency Unit, Inc., with chapters throughout the United States, promotes itself as the largest nonprofit national organization of CB radio operators. MCEU chapter members are trained to provide emergency communications for law enforcement agencies, the Red Cross, and Civil Defense. National president Ralph J. Tanner, KNP7917, Watertown, N.Y., recently appointed a committee to organize a Public Relations Department. Groups interested in starting new chapters should contact the new department at 165 W. Goguac Street, Battle Creek, Mich. 49015. Local CB clubs may apply as a body, or as few as nine individual CB operators may qualify to start a new chapter.

Current officers of the Windy City CB Radio Club, Tullahoma, Tennessee, are (seated) Mutt Ashby, president; (standing, from left) Charles Haynes, projects officer;

Chas. Solomon, sergeant-at-arms; Mrs. Mutt Ashby, secretary; Mrs. Burl Shelton, treasurer; and Burl Shelton, vice president. The Windy City group has been lauded on several occasions for their services and their donations to retarded and handicapped children associations. Last year Tullahoma Mayor Floyd Mitchell honored the group by proclaiming the week of September 1-7 as Citizens Band Radio Week, coinciding with the club's annual CB Jamboree.

I'll CB'ing you, —*Matt, KHC2060*

AMATEUR RADIO

By **HERB S. BRIER**, W9EGQ
Amateur Radio Editor

QUIRK IN RADIO LAW PROTECTS LAWBREAKERS

SPEAKING at the 15th Annual Lake County Amateur Radio Club Banquet, Ivan Loucks, W3GD, retired chief of the Amateur and Citizens Radio Services, pointed out that the secrecy provisions of the basic radio laws prevent the Federal Communications Commission from using the testimony of third parties in prosecuting violators of radio regulations. Members of the FCC must witness the violations before official action can be taken. This quirk in the law is one reason why the FCC has so much trouble getting rid of scofflaws in the Citizens Radio Service—there are so many violators and so few FCC members to observe them.

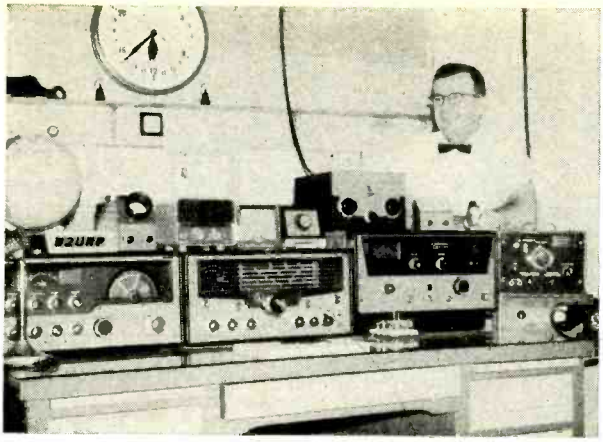
But according to W3GD, the secrecy provisions do not apply to the Amateur Radio Service (although some lawyers argue the point); therefore, conscientious amateurs can help the FCC control the few violators who give amateur radio a bad name. If you hear malicious interference, obscene or profane language, etc., in the amateur bands, carefully note the date, time, call letters names, and other details. Your logbook is a good place to log the data. Then mail a copy of the data to your district FCC office.

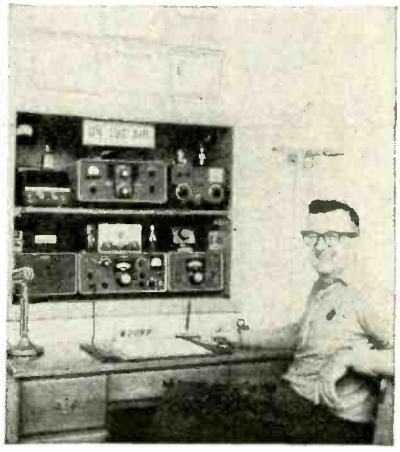
If the violations appear likely to continue for some time and are particularly serious, you may wish to alert the FCC immediately by telephone. Also, if the violations occur regularly, you can inform the FCC engineer-in-charge of the times when they usually occur.

Going a step further, W3GD said that you could record the illegal transmissions and make a written transcript of the recording. Seal the transcript in an envelope and note on the envelope what it contains. Then mail the recording and transcript and a covering letter to the FCC office. In the letter, tell why you feel that the transmissions you have recorded actually came from the station you think they did. You know how easy it is to copy call letters incorrectly or for someone to "borrow" a set of call letters. Also state your willingness to appear at a formal FCC hearing, if necessary.

AMATEUR STATION OF THE MONTH

Nine years as a U. S. Army radio operator made becoming a ham easy for Jack Folts, Jr., WA4TWI, Manassas Park, Va. Jack operates AM, CW, SSB, and FM with a Knight-Kit T-150A transmitter, EICO 753 transceiver, modified Hallicrafters SR-46 6-meter transceiver, and a Hallicrafters SR-140 receiver. His antenna farm sprouts 80- and 40-meter dipoles, a 2-element beam, Hy-Gain 18-V vertical, 6-element yagi and 5-element quad beams. Jack has worked 49 states but is almost convinced Delaware doesn't exist. WA4TWI will receive a one-year subscription for submitting the winning entry for June in our Amateur Station of the Month Photo Contest. To enter the contest, send a clear photo of your station with you at the controls and some details on the equipment you use and your ham radio career to Amateur Radio Photo Contest, % Herb S. Brier, Amateur Radio Editor, Box 678, Gary, Ind. 46401.





Seeing double? Don't worry about it. Chuck Starks, W2URP, has two amateur radio stations in his home. Below is his Collins kilowatt station built into the living room wall. At left is his Hallicrafters kilowatt station located in the basement.

Don't be disappointed if the FCC takes no apparent action on your reports; just keep making the reports. Chances are that the FCC is doing more than it seems, as a group of Indiana amateurs suddenly discovered last week. But it takes time. Incidentally, it is helpful if different people separately report illegal operations by the same operator. For one thing, multiple reports reduce the suspicion that the reports are the result of animosity between individuals.

Actually, most complaints of illegal operation are solved more satisfactorily by voluntary cooperative actions of the local amateur radio club than by official FCC actions.

Handicapped Amateurs. To eliminate "undue hardship" for physically handicapped amateurs who want Advanced or Extra Class licenses, the FCC is modifying its rules to permit such amateurs to qualify for the licenses by mail. Procedures will be essentially the same as for obtaining Novice, Technician, and Conditional Class licenses.

However, all applications for Advanced and Extra Class licenses by mail must be accompanied by a doctor's certificate attesting to the protracted nature of the applicant's physical condition that prevents him from appearing at an official examination point to take the test. Also, the volunteer examiners for these examinations must hold an amateur license at least equal in grade to the class of license being applied for.

Assuming no snafu's, these modifications should become effective shortly.

"Short Skip" Season. Peaking in June and July, but extending from mid-May until at least the end of August, the 50-MHz amateur band will often be filled with extremely strong signals from distances of 500 miles and up. Sporadic E radiations (commonly called "short skip") have been studied extensively since the phenomena were first observed by radio amateurs over 30 years ago, but all that is really known about them is that forces normally present in the E region of the ionosphere (approximately 70 miles above the earth) mysteriously combine and intensify at certain times to return high-frequency signals back to the earth over unusual distances at unusual times.

Sporadic E radiation can be observed on all amateur bands up to 148 MHz (on rare occasions), but the effects are most dramatic on the 30- and 50-MHz bands. Suddenly, extremely strong signals appear out of nowhere from places never heard under normal conditions, remain audible for periods ranging from a few minutes to several hours, and then disappear as mysteriously as they appeared. The phenomena may occur at any time; but in the United States, late morning and early evening in the summer are the most likely times.

Simplified Ohm's Law. If you have trouble calculating the value of resistances in parallel, try the system passed on by Fred, W9DOQ, McClain, Ill. Simply multiply the desired resistance by any whole number to obtain the value of one of the paralleled resistors; then divide that value by one less than the multiplier to obtain the value of the other resistance.

(*Continued on page* 87)

The replacement business, of course! Six new silicon power transistors can put you immediately into the expanding hi-fi and stereo solid-state replacement business. And, the addition of four new silicon rectifiers equip you with a full line of 1 A units with PRV ratings ranging from 200 V to 1,000 V—ideal for servicing radio and television.

RCA's SK-Series Transistors, Rectifiers, and Integrated Circuits now total 31 individual units. They can replace approximately 10,000 solid-state devices. This quality line is manufactured specifically for replacement use. There are no castoffs. No factory seconds. No unbranded culls. These are truly "Top-Of-The-Line" replacements!

See your RCA Distributor today about your supply of RCA SK-Series replacements. Ask about RCA's Replacement Catalog, SPG-202E (a complete cross-reference of foreign and domestic types), and the RCA Transistor Servicing Guide.

RCA Electronic Components, Harrison, N. J. 07029

RCA

These 10 SK devices can bring you added business

CIRCLE NO. 34 ON READER SERVICE PAGE

Look What's New

NEW HEATHKIT In-Circuit Transistor Tester

At last, a realistic price for in-circuit testing of transistors! The new Heathkit IT-18 Tester has the facilities you need and it costs a lot less. It measures DC Beta in-or-out-of-circuit in 2 ranges from 2 to 1000 (the spec. commonly used by mftrs. and schematics to determine transistor gain). It tests diodes in-or-out-of-circuit for forward and reverse current to indicate opens or shorts. Measures transistors out-of-circuit for ICEO and ICBO leakage on leakage current scale of 0 to 5,000 uA. Identifies NPN or PNP devices, anode and cathode of unmarked diodes; matches transistors of the same type or opposite types. Cannot damage device or circuit even if connected incorrectly. Big 4½" 200 uA meter. 10-turn calibrate control. Completely portable, powered by "D" cell (long battery life). Front panel socket for lower power devices. Attached 3' test leads. Rugged polypropylene case with attached cover. Build in 2 hours. 4 lbs.

NEW HEATHKIT 1-15 VDC Regulated Power Supply

Labs, service shops, hams, home experimenters . . . anybody working with transistor circuitry can use this handy new Heathkit All-Silicon Transistor Power Supply. Voltage regulated (less than 40 mV variation no-load to full-load; less than .004% change in output with input change from 105-125 VAC). Current limiting; adjustable from 10-500 mA. Ripple and noise less than 0.1 mV. Transient response 25 uS. Output impedance 0.5 ohm or less to 100 kHz. AC or DC programming (3 mA driving current on DC). Circuit board construction. Operates 105-125 or 210-250 VAC, 50/60 Hz. 6 lbs.

NEW HEATHKIT Low-Cost 5 MHz 3" 'Scope

Here is the wideband response, extra sensitivity and utility you need, all at low cost. The Heathkit IO-17 features vertical response of 5 Hz to 5 MHz; 30 mv Peak-to-Peak sensitivity; vertical gain control with pull-out X50 attenuator; front panel 1 volt Peak-to-Peak reference voltage; horizontal sweep from internal generator, 60 Hz line, or external source; wide range automatic sync; plastic graticle with 4 major vertical divisions & 6 major horizontal; front mounted controls; completely nickel-alloy shielded 3" CRT; solid-state high & low voltage power supplies for 115/230 VAC, 50-60 Hz; Zener diode regulators minimize trace bounce from line voltage variations; new professional Heath instrument styling with removable cabinet shells; beige & black color; just 9½" H. x 5½" W. x 14½" L.; circuit board construction, shipping wt. 17 lbs.

NEW HEATHKIT Solid-State Portable Volt-Ohm Meter

There's never been a better buy in meters. Solid-state circuit has FET input, 4 silicon transistors, and 1 diode. 11 megohm input on DC, 1 megohm on AC. 4 DC volt ranges, 0-1000 v, with ±3% accuracy; 4 AC volt ranges, 0-1000 v. with ±5% accuracy. 4 resistance ranges, 10 ohms center scale x1, x100, x10K, x1M, measures from 0.1 ohm to 1000 megohms. 4½", 200 uA meter with multicolored scales. Operates on "C" cell and 8.4 v. mercury cell (not included). Housed in rugged black polypropylene case with molded-in cover and handle and plenty of space for the three built-in test leads. An extra jack is provided for connecting accessory probes to extend basic ranges. Controls include zero-adjust, ohms-adjust, DC polarity reversing switch, continuous rotation 12-position function switch. Easy-to-build circuit board construction completes in 3-4 hours. 4 lbs.

NEW HEATHKIT/Kraft 5-Channel Digital Proportional System with Variable Capacitor Servos

This Heathkit version of the internationally famous Kraft system saves you over $200. The system includes solid-state transmitter with built-in charger and rechargeable battery, solid-state receiver, receiver rechargeable battery, four variable capacitor servos, and all cables. Servos feature sealed variable capacitor feedback to eliminate failure due to dirty contacts, vibration, etc.; three outputs; two linear shafts travel ⅝" in simultaneous opposite directions plus rotary wheel. Specify freq.: 26.995, 27.045, 27.095, 27.145, 27.195 MHz.

From Heath

NEW HEATHKIT AJ-15 Deluxe Stereo Tuner

For the man who already owns a fine stereo amplifier, and in response to many requests, Heath now offers the superb FM stereo tuner section of the renowned AR-15 receiver as a separate unit. The new AJ-15 FM Stereo Tuner has the exclusive design FET FM tuner for remarkable sensitivity, the exclusive Crystal Filters in the IF strip for perfect response curve and no alignment; Integrated Circuits in the IF for high gain, best limiting; elaborate Noise-Operated Squelch; Stereo-Threshold Switch; Stereo-Only Switch; Adjustable Multiplex Phase, two Tuning Meters; two variable output Stereo Phone jacks; one pair variable outputs plus two fixed outputs for amps., recorders, etc.; front panel mounted controls; "Black Magic" panel lighting; 120/240 VAC operation. 18 lbs. *Walnut cabinet AE-18, $19.95.

NEW HEATHKIT AA-15 Deluxe Stereo Amplifier

For the man who already owns a fine stereo tuner, Heath now offers the famous amplifier section of the AR-15 receiver as a separate unit. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Low Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (±1 dB, 8 to 40,000 Hz at 1 watt); Ultra-Wide Dynamic Range Preamp (98 dB); Tone-Flat Switch; Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; Massive Power Supply; All-Silicon Transistor Circuit; Positive Circuit Protection; "Black Magic" Panel Lighting; new second system Remote Speaker Switch; 120/240 VAC. 26 lbs. *Walnut cabinet AE-18, $19.95.

NEW HEATHKIT 2-Meter AM Amateur Transceiver

2-Meters at low cost. And the HW-17 Transceiver has 143.2 to 148.2 MHz extended coverage to include MARS, CAP, and Coast Guard Auxiliary operation. Output power of tube-type transmitter is 8 to 10 watts, AM. 4 crystal sockets plus VFO input. Relayless PTT operation. Double conversion solid-state superhet. Receiver has 1 uV sensitivity with prebuilt, aligned FET tuner, ANL, Squelch, "Spot" function, and lighted dial. Signal-strength/relative power-output meter. Battery saver switch for low current drain during receiving only. 15 transistor, 18 diode, 3 tube circuit on two boards builds in about 20 hours. Built-in 120/240 VAC, 50-60 Hz power supply and 3" x 5" speaker; low profile aluminum cabinet in Heath gray-green; ceramic mic. and gimbal mount included. 17 lbs. *Optional DC mobile supply, HWA-17-1, $24.95.

NEW HEATHKIT Home Protection System

Customize your own system with these new Heathkit units to guard the safety of your home and family. Warns of smoke, fire, intruders, freezing, cooling, thawing, pressure, water, almost any change you want to be warned about. Your house is already wired for this system, just plug units into AC outlets. Exclusive "loading" design of transmitters generates unusual signal which is detected by the Receiver/Alarm. Solid-state circuitry with fail-safe features warns if components of system have failed. Any number of units may be used in system. Receiver/Alarm has built-in 2800 Hz alarm and rechargeable battery to signal if power line fails (built-in charger keeps battery in peak condition). Receiver accepts external 117 VAC bells or horns. Smoke/Heat Detector-Transmitter senses smoke and 133°F. heat (extra heat sensors may be added to it). Utility Transmitter has several contacts to accept any type switch or thermostat to guard against any hazard except smoke. All units feature circuit board construction and each builds in 3-4 hours. All are small and finished in beige and brown velvet finish. Operating cost similar to that of electric clocks. Invest in safety now with this unique new low-cost Heathkit system.

NOW, THE TUNER AND AMPLIFIER OF THE FAMOUS HEATH AR-15 RECEIVER ARE AVAILABLE AS SEPARATE COMPONENTS

NEW Kit AJ-15 $189.95*

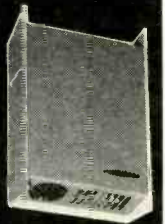
NEW Kit AA-15 $169.95*

NEW Kit HW-17 $129.95*

GD-77 Receiver / Alarm $39.95

NEW

GD-87 Smoke/Heat Detector-Transmitter $49.95



GD-97 Utility Transmitter $34.95

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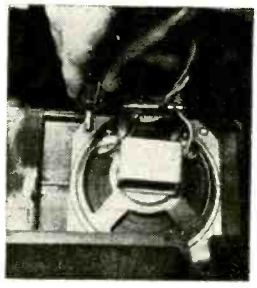
CIRCLE NO. 21 ON READER SERVICE PAGE

TIPS

(*Continued from page* 16)

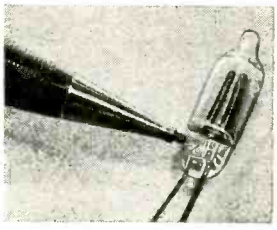
surface of the cabinets. This method of mounting speakers can be the cause of distortion of the audio signal. If the speaker mounting surface is not perfectly flat—due possibly to an error in the manufacture or subsequent warping of the cabinet—the speaker frame can become twisted out of shape when the screws anchoring it to the cabinet are tightened, causing the voice coil to rub. Try loosening the anchoring screws. If the quality of the sound improves, tighten the screws *only* to the point where they begin to bind.



—Charles Erwin Cohn

IDENTIFY GE NEON LAMP TYPES AT A GLANCE

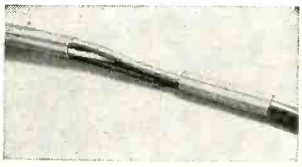
Have you been wondering how to identify the type of those miniature neon lamps you have gathering dust in your spare parts box? By carefully examining the glass bases of the individual lamps, you'll find the lamp number on one of the flat surfaces (see photo); the other flat surface has the initials "GE" stamped on it, indicating the manufacturer. Armed with these simple facts, you need never be in the dark about miniature neon lamps again.

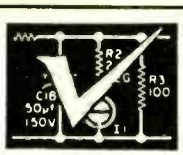


—Steve Horwitz

SOFT DRINK STRAWS MAKE NEAT WIRING HARNESSES

Instead of using multiconductor cables when you wire relays, interconnect discrete components, or fashion wiring harnesses, you can save a lot of money by neatly bundling the required number of single-conductor wires together. Then, to form a neat wiring harness, simply slip pre-cut lengths of plastic soft drink straws over the bundle of wires. Depending on how much flexibility you require from your homemade harness, the lengths of plastic straw should be between 1" and 2". The resulting harness will have a neat appearance. *—Steven Koons*





OPERATION ASSIST

Through this column we try to make it possible for readers needing information on outdated, obscure, and unusual radio-electronics gear to get help from other P.E. readers. Here's how it works: Check the list below. If you can help anyone with a schematic or other information, write him directly—he'll appreciate it. If you need help, send a postcard to Operation Assist, POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016. Give maker's name and model number of the unit. If you don't know both the maker's name and the model number, give year of manufacture, bands covered, tubes used, etc. State specifically what you want, i.e., schematic, source for parts, etc. Be sure to print or type everything legibly, including your name and address. Because we get so many inquiries, none of them can be acknowledged. POPULAR ELECTRONICS reserves the right to publish only those items not available from normal sources.

Metronix Model 545 junction transistor test set. Schematic and instruction manual needed. (Larry E. Shaw, 310 8th Ave., Asbury Park, N.J. 07712)

Saba Radio Model S-346WL; German-made, 1937. Schematic and source for parts needed. (Dale D. Duckert, 6312 Pinkney, Omaha, Nebr. 68104)

Wilcox Gay "Recordio" Model A87 phono, AM and SW radio receiver, and public address system. Schematic needed. (Fred Hoffmann, P.O. Box 308, Henderson, Ark. 72544)

Solar Manufacturing Model CB-1-60 capacitor analyzer. Schematic and operating manual needed. (Robert E. Kann, 5710 122nd Ave., S.E., Bellevue, Wash. 98004)

RCA Model 169 "Dynamic Demonstrator." Instruction manual needed. (Elmer Schwartz, RR 1, Cloverdale, Ohio 45827)

Sylvania 400 oscilloscope. 7JP1 oscilloscope tube needed. (S. Goldber, 1014 B St., Hayward, Calif. 94541)

EICO Model 400 oscilloscope. Schematic and instruction manual needed. (H. F. Stevens, 310 N.E. Fifth St., Mulberry, Fla. 33860)

Hallicrafters Model S-38A short-wave receiver. Schematic, alignment data, and parts source needed. (Robert Brimson, 4209 Hermitage Rd., Virginia Beach, Va. 23455)

Atwater-Kent Model 30 and 44 radio receiver. Schematic, service data, and information on Type E radio speaker for above needed. (Cranz L. Nichols, P.O. Box 781, Schertz, Texas 78154)

Hallicrafters ID2480 tuner. Schematic and tube numbers needed. (Ray C. Counterman, 42 Elizabeth St., Wilkes-Barre, Pa. 18702)

"Viking" Model Z-40A75-E-1 radio receiver, made by Dominion Electrohome Industries. Schematic and tube placement diagram needed. (Lyle C. Fahlman, 54 Bayview Dr., Transcora 25, Manitoba, Canada)

Electric Eye Equipment Co. electronic keyer; has 3 tubes. Schematic needed. (Alfred Boatman, 738 N. Chestnut Ave., Cookeville, Tenn. 38501)

RCA Model AR-77-E communications receiver. Schematic and operating manual needed. (Kamal Mokayesh, c/o British Embassy, Beirut, Lebanon)

(*Continued on page* 82)

ASSIST (*Continued from page 81*)

Heathkit Model DX 100-B. Construction and maintenance data, operating manual, and schematic needed. (J. Brodsky, P.O. Box 73-Airport, Jamaica, N.Y. 11430)

Triumph Model 830 oscilloscope. Schematic and operating manual needed. (Raymond C. Kiesling, 805 Lincoln Dr., Brookhaven, Pa. 19015)

"Sky Chief" radio receiver. Schematic and 1A7GT, 1H5GT, 1N5GT, and 3Q5GT tubes needed. (David L. Kotula, RD #2, Emporium, Pa. 15834)

RCA Model AVT-112A aircraft transmitter. Loading and antenna coupling coils needed. **RCA** Model 320 6-band receiver. Schematic, alignment data, and parts source for both needed. (Steve LaForge, 6303 Oakland Dr., Portage, Mich. 49002)

Detrola Model 327 radio receiver. Schematic or list of tubes needed. (Ken Lombardi, 1853 Huntington, Grosse Pte. Woods, Mich. 48236)

RCA Victor Model 5647 "Nipper" AM radio receiver. Schematic needed. (Lawrence Meikle, R.R. #1, Richmond Hill, Ont., Canada)

Western Royal receiver; covers 19, 25, 31, and 49 meters, and BCB; has 11 tubes. Schematic and parts list needed. (P. Keim, 8414 S.E. Glenwood St., Portland, Ore. 97266)

EICO Model 470 oscilloscope. Construction manual needed. (Wilfred Yusek, 126 Stone Church Rd. W., Hamilton, Ont., Canada)

Hallicrafters Model S-77A receiver. Schematic and manual needed. (Randy Bell, 7725 Pontiac Dr., Pensacola, Fla. 32506)

"Duchess" Model EC 1000-BWT solid-state AM, FM stereo receiver, made in Japan. Schematic and operating manual needed. (Joseph S. Sabo, 313 Sixth St., Fairport Harbor, Ohio 44077)

Webcor Model 228-1 wire recorder. Schematic needed. (Vincent Kovach, 1373 E. 53 St., Cleveland, Ohio)

Hallicrafters Model S-38 receiver. Schematic and good used band #4 coils needed. (Joseph A. Smith, 520 N. Edward St., Decatur, Ill. 62522)

Gonset Model 3010 receiver. Schematic and information on audio amplifier and power supply needed. (Robert M. Ivey, 4718 Ancilla Dr., Garland, Texas 75040)

Sparton Model 1466 a.c. receiver. Schematic needed. (J. Harriman, 3134 S. 29 Court, LaCrosse, Wis. 54601)

Heathkit Model "03" oscilloscope, 1948. Operating manual needed. (Gerald L. Osier, P.O. Box 5, Clearlake, Wash. 98235)

Fairbanks Morse Model 9A receiver, 1937. Schematic and source for parts needed. (Robert L. Beck, 256 Blackiston Ave., Cumberland, Md. 21502)

Hallicrafters Model S-36 UHF receiver. Operating manual, schematic, and source for r.f. gain control and r.f. gain knob needed. (Thomas A. Ross, Rte. 1, Box 137A1, Irma, Wis. 54442)

"Mark II" tank transceiver, series C-11290, circa 1942. Operating manual and conversion data needed. (Mark Wojciechowski, 42 Granite St., Weymouth, Mass. 02188)

Packard Bell "PhonOcord" record cutter. Operating manual needed. (Fred B. Clevenger, 6325 Rathke, Riverside, Calif. 92509)

SOURCES OF INFORMATION

"Operation Assist" is published as a service to the readers of POPULAR ELECTRONICS who cannot find schematics, parts, etc., for old or no-longer-manufactured equipment. Military—or Government surplus—equipment is not itemized in this column, since schematics and copies of Tech Manuals for military equipment can be obtained from a variety of independent sources: Slep Electronics, Drawer 178, Ellenton, Florida 33532; Quaker Electronics, P.O. Box 215, Hunlock Creek, Pa. 18621; etc. Unusual or difficult-to-find schematics and servicing information can frequently be obtained from Supreme Publications, 1760 Balsam Rd., Highland Park, Ill., for a slight charge.

ELECTRONICS library

QUIET

UNDERSTANDING SILICON CONTROLLED RECTIFIERS

by Saul Heller

Because the silicon controlled rectifier plays an important role in modern electronics, it is essential that today's technician and serious hobbyist become familiar with this device. Beginning with a review of semiconductor fundamentals, this book gives the reader a run-down on how the SCR is made, how it operates, and what its capabilities are. Many useful schematics illustrate application of various SCR's as static switches, phase-control switches, inverters, choppers, etc. And, finally, the book tells you how to select the proper SCR for a given job.

Published by Hayden Book Co., Inc., 116 West 14 St., New York, N.Y. 10011. Soft cover. 134 pages. $3.50.

APPLIED MATHEMATICS FOR ELECTRONICS

by John H. Westlake and Gordon E. Noden

Bridging the gap between pure mathematics and math applications in electronics, this book will help minimize the confusion sometimes caused by abstracts. As each new application is presented, it is thoroughly discussed and accompanied by carefully prepared examples to clarify the subject. Trigonometry, complex algebra, the mathematics of two-port networks, Boolean algebra, and the mechanization of logic are all covered. The last three chapters, devoted to a complete self-study course on the implementation of digital computer hardware, are by themselves worth the cost of this book.

Published by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Hard cover. 608 pages. $12.25.

ABC'S OF TRANSFORMERS AND COILS, SECOND EDITION

by Edward J. Bukstein

Transformers and coils are basic building blocks in electronic equipment, and the theory and application of these devices are as important to the field as Ohm's law is to d.c. circuits. This second edition covers magnetic-core memory and logic circuits, toroidal and ferrite bead inductors so vital to computer technology, in addition to the general theory of inductors discussed in the first edition. Important mathematical relationships and formulas are presented—but not as a substitute for adequate explanatory text. Written in the fluid "ABC" style, this book

should be easy to understand even by beginners.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, Ind. 46268. Soft cover. 96 pages. $2.25. —30—

TAKE ONE new literature

To obtain a copy of any of the catalogs or leaflets described below, simply fill in and mail the coupon on page 15.

Some 12,000 transistors, rectifiers, zener diodes, dual diodes, and SCR semiconductor devices are cross-referenced in alphanumeric order in the new Motorola HEP replacement guide. In addition, the 55-page guide contains tips on using universal replacement semiconductors, outline dimensions of HEP devices, and a HEP price list.

Circle No. 88 on Reader Service Page 15

Over 100 forthcoming books are described in the 16-page 1968 catalog released by *TAB Books*. Among the subjects covered are broadcasting, basic technology, CATV, electric motors, electronic engineering, electronics servicing, hi-fi stereo, test instruments, and transistors.

Circle No. 89 on Reader Service Page 15

A 26-page catalog put out by *Mosley Electronics, Inc.*, covers all types of amateur radio antennas available, plus accessories for stacking, mounting, conversion, and coax lead-in. Included is a comprehensive discussion of traps, feed systems, unbalanced radiators, SWR, and other pertinent topics.

Circle No. 90 on Reader Service Page 15

Aerotron, Inc., has announced the availability of two new *AMECO* books to help radio amateurs upgrade their licenses. Catalog #16-01 is designed for the ham with a General Class license who wants to obtain an Advanced Class license, while Catalog #17-01 is intended for the Advanced Class amateur who is aiming for an Extra Class license. Both books combine FCC questions with easy-to-understand answers, practice examinations with FCC-type multiple-choice answers, and questions grouped by subjects for easy study. These catalogs can be obtained from numerous radio distributors throughout the country. The 16-01 costs 50 cents; the 17-01, 75 cents. —30—

SOLID STATE

(*Continued from page 70*)

though there is a definite relationship between the various terms in common use, unless this relationship is clear to the user, he may run into considerable difficulty not only in comparing different transistors but even in selecting a suitable transistor for a specific application.

For example, given the choice of two transistors for an r.f. circuit, all other factors being equal, which would *you* choose—one with a *beta cutoff* of 100 kHz, or another with a *figure of merit* of 2 MHz?

If you picked the one with a *beta* cutoff of 100 kHz, you'd probably be right, for the chances are that *its* figure of merit would be on the order of 6 or 7 MHz.

Which is the better transistor for a 2-MHz oscillator—one with a *beta cutoff* of 2 MHz, or one with an *alpha cutoff* of 5 MHz?

Again, if you picked the 2-MHz unit, you'd probably be right, for *its alpha* cutoff might be as high as 200 MHz, or more.

The various terms you may encounter can be defined as follows:

Alpha cutoff is the frequency at which the transistor's gain in the common-base configuration is 0.707 of its low-frequency value (generally, at 1 kHz). This term is now almost obsolete.

Beta cutoff is the frequency at which the transistor's gain in the common-emitter configuration is 0.707 of its low-frequency value (at 1 kHz). This may be relatively low compared to the other ratings used, even for a fairly "good" transistor. For example, a unit with a *beta* of 100 and a *beta* cutoff of only 1 MHz has a *very respectable* gain of 70.7 at 1 MHz.

Transconductance cutoff is the frequency at which the transistor's transconductance is 0.707 of its low-frequency value.

Figure of merit, gain-bandwidth product and *maximum frequency of oscillation* are nearly the same—that is, the frequency at which the transistor's gain is reduced to unity. In actual practice, however, the maximum frequency of oscillation may be somewhat higher than, say, the gain-bandwidth product, for the latter term may be expressed in terms of *beta* by some manufacturers, while the maximum frequency of oscillation depends on *power gain* rather than *beta*. In other words, a transistor still may deliver some power gain even when its *beta* is reduced to 1.0 due to the differences between its input and output impedances—and, as long as there is power gain, oscillation may be possible.

The gain-bandwidth product is useful for

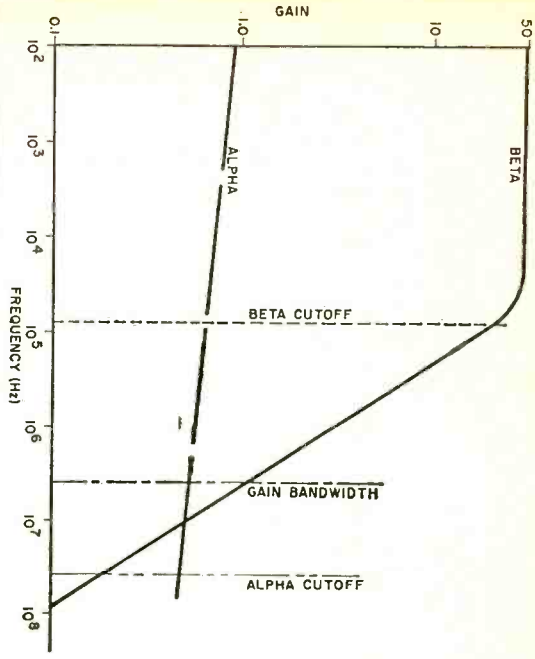


Fig. 5. This graph will help you distinguish between the various terms used to define the r.f. characteristics found in transistor specifications.

"rule of thumb" estimates when designing wideband (video) amplifiers. Simply divide this figure by the bandwidth of the amplifier to determine the average maximum gain that can be achieved. For example, if a transistor has a gain-bandwidth product of, say, 50 MHz, it should be able to deliver a gain of 10 as a d.c.-to-5-MHz amplifier.

Alpha cutoff, *beta* cutoff and gain-bandwidth product relationships are illustrated graphically in Fig. 5. Although actual frequency values and gain figures may vary considerably with different transistors, the general relationships shown are essentially the same for all units.

That's the end of our story for this month . . .

—Lou

CAPACITOR QUIZ ANSWERS

(*Quiz appears on page* 63)

1	10 pF	6	8 pF
2	6 pF	7	5 pF
3	12 pF	8	3 pF
4	9 pF	9	15 pF
5	16 pF	10	4 pF

AMATEUR RADIO

(*Continued from page 76*)

Example: Assuming that you have a 2000-ohm resistor and need 400 ohms, what size resistor should you connect across the 2000-ohm resistor to obtain 400 ohms?

Solution: 2000 is five times 400. Subtract one from five, leaving four. Divide 2000 by four, giving 500. Ergo, 2000 ohms in parallel with 500 ohms equals 400 ohms.

Incidentally, the same method works for capacitors in series.

Field Day. The 1968 "Field Day" sponsored by the American Radio Relay League, Inc., is scheduled for between 2100 GMT, June 22, and 2400, GMT, June 23. You can operate for any consecutive 24-hour period, working other emergency-powered or home stations. All amateur bands may be worked simultaneously.

Field Day is both the most popular and the most important operating event of the year because of its underlying purpose of giving amateurs experience in setting up and operating emergency-powered stations under simulated emergency conditions. Carefully check this year's rules in *QST* because they are somewhat different than last year's rules.

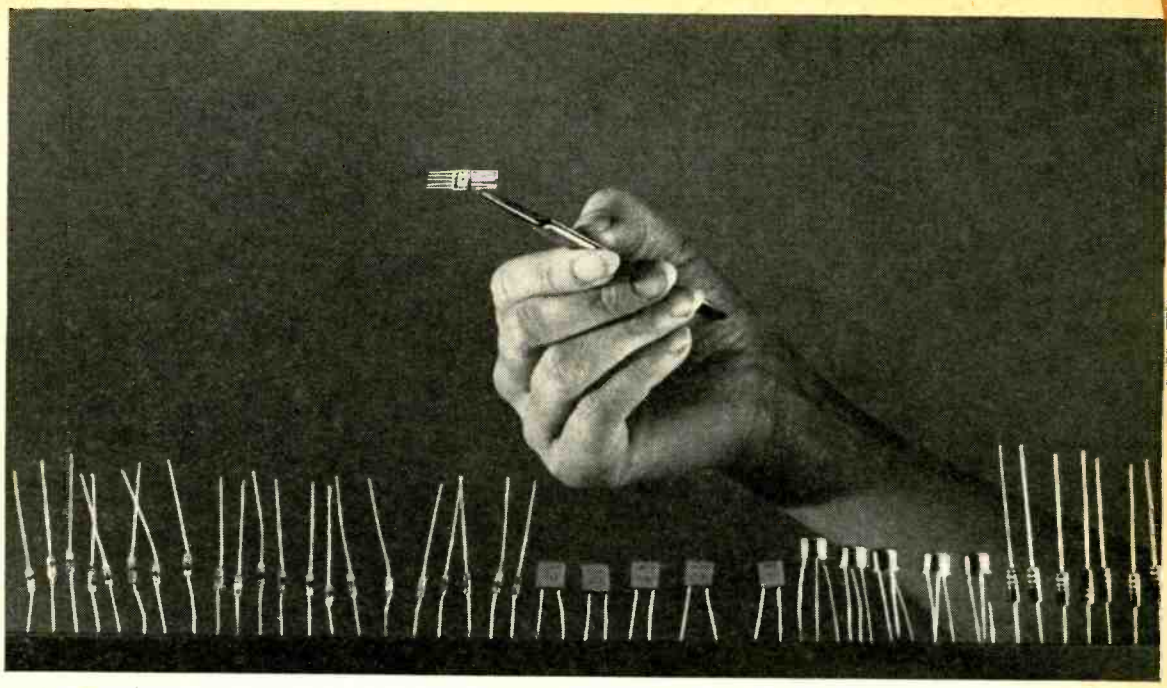
Overseas Items. At the request of the Wireless Institute of Australia, the Australian "FCC" has recently reduced the code speed requirements for an Australian amateur license from 14 to 10 words per minute.

Reporting in the January, 1968, issue of *Radio Communication* (formerly the RSGB *Bulletin*), G6XN tells of working 12 U.S. and Canadian stations on 21- and 28-MHz SSB from England with a 1-watt PEP output transistor transmitter. The antennas were dipoles 20 feet high, and reports were as high as S9. Using a quad antenna and lower power, Australia was worked with S6 reports several times on both bands.

NEWS AND VIEWS

Rex Carlson, WA5QKL, 610 Mississippi Ave., Borger, Texas, must be on a "new license a year" program. He got his Novice ticket when he was 12, his General when he was 13, and will soon try for his Advanced now that he is 14. When not working for new licenses, Rex is on 10, 15, 20 and 40 meters with a Johnson "Ranger" transmitter and a Drake 2-B receiver. **Larry Alwardt, WN9WPO,** R.R. 1, Strasburg, Ill., complains that it took 10 weeks for his license to arrive. (This is a little longer than the usual three to six weeks but far from a record.) Larry works the three low-frequency Novice bands with a dipole antenna tied to an EICO 723 transmitter and Drake 2-A receiver. His first ten days of operation netted eight states and

(*Continued on page 92*)



50 functions in a single chip. *The functions of 50 separate transistors, diodes, resistors and capacitors can now be formed by the tiny dot in the center of the integrated circuit held by the tweezers.*

The "Chip"

...will it make or break your job future?

THE DEVELOPMENT OF INTEGRATED CIRCUITRY is the dawn of a new age of electronic miracles. It means that many of today's job skills soon will be no longer needed. At the same time it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the gigantic coming boom, and how you can learn it right at home.

TINY ELECTRONIC "CHIPS," each no bigger than the head of a pin, are bringing about a fantastic new Industrial Revolution. The time is near at hand when "chips" may save your life, balance your checkbook, and land a man on the moon.

Chips may also put you out of a job...or into a better one.

"One thing is certain," said *The New York Times* recently. Chips "will unalterably change our lives and the lives of our children probably far beyond recognition."

A single chip or miniature integrated circuit can perform the function of 20 transistors, 18 resistors, and 2 capacitors. Yet it is so small that a thimbleful can hold enough circuitry for a dozen computers or a thousand radios.

Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new desk-top computer, no bigger than a typewriter yet capable of 166,000 operations per second. And it is almost possible to put the entire circuitry of a color television set inside a man's wrist-watch case.

And this is only the beginning!

Soon kitchen computers may keep the housewife's refrigerator stocked, her menus planned, and her calories counted. Her vacuum cleaner may creep out at night and vacuum the floor all by itself.

Money may become obsolete. Instead you will simply carry an electronic charge account card. Your employer will credit your account after each week's work and merchants will charge each of your purchases against it.

When your telephone rings and nobody's home, your call will automatically be switched to the phone where you can be reached.

Doctors will be able to examine you internally by watching a TV screen while a pill-size camera passes through your digestive tract.

New Opportunities for Trained Men

What does all this mean to someone working in electronics who never went beyond high school? It means the opportunity of a lifetime—if you take advantage of it.

It's true that the "chip" may make a lot of manual skills no longer necessary.

But at the same time the booming sales of articles and equipment using integrated circuitry has created a tremendous demand for trained electronics personnel to help design, manufacture, test, operate, and service all these marvels.

There simply aren't enough college-trained engineers to go around. So men with a high school education who have mastered the fundamentals of electronics theory are being begged to accept really interesting, high-pay jobs as engineering aides, junior engineers, and field engineers.

How To Get The Training You Need

You can get the up-to-date training in electronics fundamentals that you need through a carefully chosen home study course. In fact, some authorities feel that a home study course is the best way. "By its very nature," stated one electronics publication recently, "home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative." These are qualities every employer is always looking for.

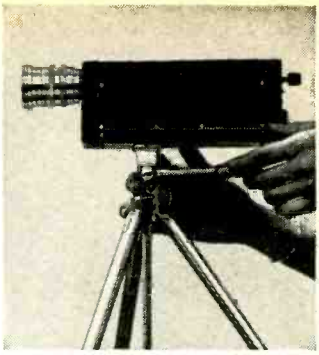
If you do decide to advance your career through spare-time study at home, it makes sense to pick an electronics school that specializes in the home study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of correspondence training.

The Cleveland Institute of Electronics has everything you're looking for. We teach only electronics —no other subjects. And our courses are designed especially for home study. We have spent over 30 years perfecting techniques that make learning electronics at home easy, even for those who previously had trouble studying.

Your instructor gives your assignments his undivided personal attention—it's like being the only student in his "class." He not only grades your work, he analyzes it. And he mails back his corrections and comments the same day he gets your lessons, so you read his notations while everything is still fresh in your mind.

Always Up-To-Date

Because of rapid developments in electronics, CIE courses are constantly being revised. Students receive the most recent revised material as they progress through their course. This year, for example, CIE students are receiving exclusive up-to-the-minute lessons in Microminiaturization, Logical Troubleshooting, Laser Theory and Application, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra. For this reason CIE courses are invaluable not only to newcomers in Electronics but also for "old timers" who need a refresher course in current developments.



Tiny TV camera *for space and military use is one of the miracles of integrated circuitry. This one weighs 27 ounces, uses a one-inch vidicon camera tube, and requires only four watts of power.*

Praised by Students Who've Compared

Students who have taken other courses often comment on how much more they learn from CIE. Mark E. Newland of Santa Maria, California, recently wrote: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand. I passed my 1st Class FCC exam after completing my course, and have increased my earnings $120 a month."

Get FCC License or Money Back

No matter what kind of job you want in electronics, you ought to have your Government FCC License. It's accepted everywhere as proof of your education in electronics. And no wonder—the Government licensing exam is tough. So tough, in fact, that without CIE training, two out of every three men who take the exam fail.

But better than 9 out of every 10 CIE-trained men who take the exam pass...on their very first try!

This has made it possible to back our FCC License courses with this famous Warranty: you *must* pass your FCC exam upon completion of the course or your tuition is refunded in full.

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CIRCLE NO. 11 ON READER SERVICE PAGE

an RCC (Rag Chewers' Club) certificate. A 15-meter beam is in the planning stage . . . **Ken S. King, WN1ISK,** and his father, **Leo F. King, WN1ISW,** 1 Church St., Taunton, Mass., share the same equipment. They use a Heathkit DX-60A transmitter and HR-10 receiver in conjunction with a Hy-Gain 14-AVQ vertical antenna 70 feet high. Leo doesn't have as much time to operate as Ken does; so their respective states-worked totals are 5 and 30—all on 15 and 40 meters.

Al R. Lane, WN8YYY, 13845 Long Lake Dr., Sparta, Mich., spends most of his time on 80 meters, where he has worked 23 states in three months. His transmitter is a Knight-Kit T-60 exciting a 100′, end-fed antenna. A 22-year-old Hallicrafters S-38 receiver completes his "bare essentials" station. As a hobby within a hobby, WN8YYY would like to work other stations with the same call letter repeated three times after the number. To date, he has worked WN9UUU . . . **Joel A. Henebry, WN2DCH,** Box 266, Salt Point, N.Y., mentions his receiver—a Lafayette HA-500—first in the list of gear that allowed him to rack up 24 states, Canada, and Puerto Rico. Also on the equipment list is a Heathkit DX-60B transmitter, Johnson "Match Box" antenna coupler, electronic T/R (transmit/receive) switch, and dipole antennas for 80 and 40 meters . . . **Andy Estrine, WA1GTV,** 47 Aqueduct Rd., Wayland, Mass., works 20-meter SSB with a Heathkit HW-32A transceiver feeding a Mosley TA-31 "one-element beam." (At a later date, other elements can be added to it to produce a two- or three-element, tri-band beam. In less than a year, Andy has worked 47 states and 65 countries in all continents. He is now converting a war-surplus transmitter, so that he can operate on 40-meter CW. Andy is trustee for the Wayland High School Radio Club (he forgot to include its call letters) which operates on 40-meter CW. Club members would like skeds with other club stations as well as pointers on running the club.

Robert Denniston, WØNWX, Newton, Iowa, worked KA9MF on 160 meters on January 28 to become the fourth amateur ever to work all continents on 160. Bob was running 50 watts to a 700′ antenna, 75 feet high on one end, 50 feet high on the other. Bob, by the way, is president of the American Radio Relay League . . . **Mike Sullivan, WN3ISM,** 120 Circle Av., Pittsburgh, Pa., reports his best DX—on 80 meters—to be Arkansas. His Knight-Kit T-60 transmitter, coupled to a 75′ antenna through a home-built antenna coupler, and a war-surplus BC-348Q receiver have worked eight other states and Canada on 80 meters . . . **Mark E. Halliday, WA3MHU,** 24 Scott Rd., Doylestown, Pa., worked 13 countries in five days after getting his General license, to go with the 39 states he worked as a Novice. Five of the eleven members of the Central Bucks High School Electronics Club have an amateur ticket (including a YL, Pam, WN3INL), three others have passed the tests, and two more are about ready for their tests. The club just held a "car wash" to earn the money to buy a power supply for its one piece of amateur gear—a Heathkit HW-22 7-MHz transceiver . . . **Jeffrey H. Siegell, WB2YRL,** 75-24 263 St., Glen Oaks, N.Y., takes a dim view of the practice of some hams—in contests especially—to break in unceremoniously on a contact simply because they want to work one of the stations in the contact. There is no law that says you have to welcome a rude "breaker." But most operators in a contest cluster in small segments of the bands; therefore, if you don't want to participate in a contest, just operate in another portion of the band while the contest is going on.

Your "News and Views" and photographs are the backbone of this column; so when are *you* going to send *yours*? Thanks for seeing to it that the club papers and bulletins keep coming. Send all mail to: Herb S. Brier, W9EGQ, Amateur Radio Editor, POPULAR ELECTRONICS, P.O. Box 678, Gary, Ind. 46401.

73, *Herb, W9EGQ*

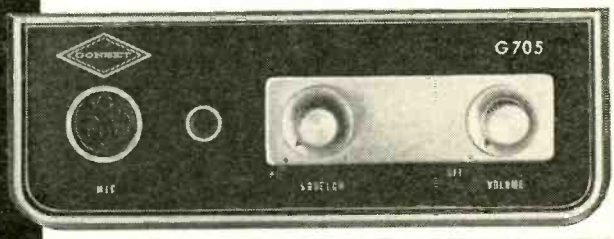
PEOPLE DETECTOR

(*Continued from page* 32)

—then, as he approaches the display, the instrument switches on spotlight *I2* to highlight the new product. If preferred, electric chimes, a gong, or even a programmed tape message could be actuated in addition to (or instead of) the second lamp. An arrangement similar to this one would be suitable for a Science Fair display.

There are, of course, innumerable short-range applications for the device. Typically, it could be used as a proximity (touch) control for office or shop equipment, by an amateur or professional magician to operate a mechanically actuated illusion, as an industrial control for production line process equipment, as a limit control or as a "through the window" remote control for a mechanical store window display. Here, the proximity antenna plate is concealed behind a sign mounted on the inside of the store's window, while the instrument can control an electric train, model car, or any other type of attention-getting display; the sign could carry the legend "PLACE HAND HERE."

If you don't have a serious application in mind, the "People Detector" is appropriate for a variety of "fun" situations or as a conversation piece in a recreation room or bar. For example, if the control antenna is hidden under a bar counter, the instrument can be wired to sound a gong or flash a light (such as a strobe) every time a guest reaches for his drink. —30—



SHORT-WAVE LISTENING

(*Continued from page 71*)

and 10 Canadian provinces verified; while Bernard Hughes, G2PE6D, of Worcester, England, has 170 countries and 40 states verified.

Time Stations. While the National Bureau of Standards Station WWV is the most well known, there are many other stations on the air that provide time and standard frequency information. For a complete listing of these stations, write to your Short-Wave Editor, and ask for a copy of Leaflet L, enclosing a six-cent stamp for return postage.

CURRENT STATION REPORTS

The following is a resume of current reports. At time of compilation all reports are as accurate as possible, but stations may change frequency and/or schedule with little or no advance notice. All times shown are Greenwich Mean Time (GMT) and the 24-hour system is used. Reports should be sent to SHORT-WAVE LISTENING, P.O. Box 333, Cherry Hill, N.J., 08034, in time to reach your Short-Wave Editor by the fifth of each month; be sure to include your WPE identification.

Afghanistan—Kabul, 11.746 kHz, has native language to 1800 and Eng. to 1828 s/off; some native music and a poor level signal.

Albania—English is aired from Tirana at 0130-0200 and at 0300-0330 on 6180 and 7295 kHz. New channels in use include 11,938 kHz at 1430 with native-language news, and 9490 kHz from 2115 to past 2220 in English. An Eng. xmsn is given at 2200 on 1395 kHz, but summer is not the best time of the year to try for this one!

Ascension Island—The BBC relay has a number of new frequencies in use: 15,435 kHz to Africa at 0730; 15,400 kHz in Eng to 2130, then into French; 15,105 kHz to 2000 closing; 7240 kHz at 0400 with news; and 7105 kHz in French at 0430, dual to 9600 kHz.

Biafra—*Voice of Biafra,* Enugu, is noted often between 0500 and 0630 on 6145 kHz in English. Following the suspension of postal service between the U. S. and this country, some DX'ers tried to send reports via Nigeria but postal service has also been suspended between Biafra and Nigeria.

Bolivia—*R. Norte,* Montero, after a brief stay on 4961 kHz, has returned to its assigned frequency of 4940 kHz, where it is heard in Spanish from 2300 to 0300 s/off. Listeners needing this country might try for *La Cruz del Sur,* CP75, La Paz, 4985 kHz, when the station presents "English By Radio" at 2245.

Brazil—Station ZYA, *Radiodifusora Roraima,* Boa Vista, 4835 kHz, has Portuguese around 0145 with commercials, pop tunes and ID's every 15 minutes. Station ZYO21, *R. Cultura de Cuiaba,* Cuiaba, 5055 kHz, is on the air irregularly with s/off around 0100 in Portuguese. *R. Nacional,* Brasilia, has been heard at 0849 with music and anmts.

Canada—Station CFVP, *Calgary,* 6030 kHz, has been heard relaying CFCN's telephone call-in program which must be something of a first for short-wave radio; the time was 0530; news was given at 0600. (Editor's Note: We have often heard some of the eastern Canadian stations with telephone call-in sessions but these have been mainly for the sale or swapping of various items. Presumably, CFCN's program is a discussion-type call-in period.)

China—*R. Peking,* at press time, was beamed in Eng. to N.A. at 0000 on 15,060 and 17,680 kHz, at 0100 on 15,060, 11,720, 9780, and 7120 kHz, and at 0200 on 15,060, 11,945, and 11,720 kHz. More Eng. was noted at 0325 on 7100 kHz. Home Service xmsns in Chinese were reported at 0810 on 9020 kHz, and at 1250 on 5320 kHz. Your Short-Wave Editor has been hearing Eng. on 15,060 kHz from 1230 to 1255 s/off with news and music, and again at 1300 with more Eng. news.

Egypt—A new frequency for Cairo is 15,175 kHz, noted at 1418 in Home Service xmsn with Arabic music.

England—The BBC, London, was tuned on 11,970 kHz at 0710 with news, then a commentary; and on 15,200 kHz at 2200-2245 in the World Service to the West Indies and Central America, with news at 2200. Both are new channels.

French Guiana—A West Coast listing shows that Cayenne has been noted there on 4894 kHz with French music to 0100, no ID on the hour, continuing with pop music.

SHORT-WAVE ABBREVIATIONS

anmt—Announcement
BBC—British Broadcasting Corporation
B/C—Broadcasting
Eng.—English
ID—Identification
IS—Interval signal
kHz—Kilohertz
kW—Kilowatts
MHz—Megahertz
N.A.—North America
R.—Radio
s/off—Sign-off
s/on—Sign-on
VOA—Voice of America
xmsn—Transmission
xmtr—Transmitter

Ghana—Recent loggings of *R. Ghana,* Accra, include 11,850 kHz in Eng. to N.A. at 2000-2100; 6140 kHz at 0310 with Eng. news; and 4920 kHz at 0600 with Eng. news. Your Short-Wave Editor has been hearing the 4920 kHz outlet in Eng. from 2100 to 2215 regularly.

Guam—Utility station KUK25, Agana, operated by RCA Communications, 15.475 kHz, often relays calls from servicemen to the United States. Listen from 2200 to 0300.

Indonesia—A seemingly new outlet for *R. Republik Indonesia* has been heard at strong level from 1145 to 1200 on 7269 kHz with music.

Israel—*Kol Israel* now has four half-hour xmsns daily in Russian to Europe at 1530, 1700, 1930, and 2130 on 9009, 9625, and 9725 kHz. Another xmsn, thought to be in Russian, with western-type music has been noted on 9009 kHz at 0430-0445 only.

Lebanon—*R. Lebanon,* Beirut, has Portuguese to South America at 2300 on 15,340 kHz.

Malaysia—*R. Malaysia,* Kuala Lumpur, has been noted on a new frequency of 9710 kHz in Malaysian at 0935.

Mozambique—According to James Hart, Short-Wave Editor for the *Newark Sunday News, R. Pax, Emissora Catolica,* Beira, is currently being heard well on 7205 kHz at 2000 in Portuguese and African vernaculars. Verification is said to be easy to obtain, and reports go to the station at C. P. 594, Beira. Return postage is requested and appreciated.

Netherland Antilles—*Trans World Radio,* Bonaire, has religious programs in Spanish at 2230-2300 and in Portuguese to 2330 on 15,350 kHz, and in Eng. at 0230-0300 on 9695 kHz. Your Short-Wave Editor's latest logging shows Spanish to southern South America on 15,220 kHz at 2230-2320, with many talks and some barrel-organ music such as is usually noted on Eddie Startz' "Happy Station Program," Sundays, from Hilversum.

Nigeria—Recent tunings from Lagos include: 15,155 kHz, at 0700 to Europe and weak; 11.900 kHz, with s/off at 0000, two hours behind the scheduled s/off; 11.770 kHz in French at 2040 and in Eng. at 2100; and 4990 kHz, in the Eng. and Afrikaans Commercial Service at 2330.

Norway—*R. Norway* has been noticed lately operating on 11.850 and 11.860 kHz simultaneously, but obviously beamed to different targets: news in Eng. is heard at 2000 and in native language at 2010. The 9610-kHz outlet carries a Norwegian request program at 0400-0430; an Eng. ID is given at 0430.

Peru—On 3358 kHz for many years, OAX3D, *R. Huanuco,* Huanuco, has moved up to 4961 kHz, where it is tuned at 0300 and later with lengthy Latin American musical selections and very few station announcements of other ID.

Philippines—*South East Asian Radio Voice,* Manila, is testing its 50-kW xmtr on 17.715 kHz at 2330-0130 and on 15,420 kHz at 1100-1300, beamed to Thailand and Burma. Reception reports are urgently requested; address them to SEARV, Box 4148, Manila.

Portugal—*R. Lisboa,* Lisbon, has Portuguese to South America on 15.320 kHz at 2345-0030 with news at 0015; this channel is dual to 9585 kHz.

Rhodesia—The schedule of the General Service of the Rhodesia B/C Corp. is: 0555-0635 and 1825-2300 (Sundays at 1825-2205) on 3396 kHz; 0555-1830 (Sundays from 0730) on 6020 kHz; and 0655-1815 (Sundays from 0730) on 7285 kHz. Another xmsn was noted from 0400 to 0430 fade on 3306 kHz in Eng. and another language in the Commercial Service.

Saudi Arabia—Jeddah's 19-meter outlet has been moving around but at press time is on 15,160 kHz in Arabic at 2035-2110 and later. Another xmsn has been noted with s/on at 0357.

South Africa—*R. RSA's* current schedule to the U.S. and Canada is 2330-0030 on 15.220 and 11.875 kHz, and 0030-0130, 0130-0230, and 0230-0330 on 11,875 and 9705 kHz. Your Short-Wave Editor and

others have also monitored 17.790 kHz with French to Europe from 1800 to 1850 s/off, Eng. at 1900-1950, and Eng. news at 2100-2150.

Sweden—Schedule changes from *R. Sweden* include: German being broadcast at 1945-2015 on 6065 kHz; the xmsn to Eastern N.A. at 1100-1215 changed from 15.240 to 11,880 kHz and at 1400-1530 from 21.585 to 17.770 kHz; the Western N.A. xmsn at 1600-1700 moving from 15,240 to 15.310 kHz; and the omnidirectional xmsn at 1230-1330 being adjusted from 21,690 to 21,675 kHz. Reports are requested.

U.S.S.R.—West Coast loggings show *R. Yerevan* with Eng. news at 0430 on 11,890 kHz—a weak signal. Vladivostok relays *R. Moscow* on 9770 kHz at 0730—it was noted with a radio play in Russian; other Vladivostok outlets were found on 4610 kHz at 1236 in Russian and on 4885 kHz at 0452 with beautiful Russian music. On 7195 kHz, a station being heard from 0200 is believed to be Tula relaying one of Moscow's various services, with IS and time pips.

Vatican City—A new frequency for *Vatican Radio* is 17,730 kHz, found at 1730 in French.

Venezuela—A new, unlisted station is *R. de la Cruz*, 4940 kHz, noted at 0230-0330 with Latin

SHORT-WAVE CONTRIBUTORS

Stan Mayo *(WPE1GMF)*, Portland, Me.
Conrad Baranowski *(WPE1GXX)*, Boston, Mass.
Mark Connelly *(WPE1HGI)*, Arlington, Mass.
Robert Lazar *(WPE1HHS)*, Plainville, Conn.
William Graham *(WPE2LMU)*, Binghamton, N. Y.
Peter Macinta, Jr. *(WPE2ORB)*, Kearny, N. J.
Bernie Lansing *(WPE2PBA)*, Rochester, N.Y.
Andrew Jezioro *(WPE2PCB)*, Cheektowaga, N. Y.
Ed Sobota *(WPE2PJR)*, Fulton, N. Y.
Thomas Henry *(WPE2PSZ)*, Staten Island, N. Y.
Frank Wood *(WPE2PUO)*, Pennsauken, N. J.
Mark Ortner *(WPE2QCM)*, North Java, N. Y.
George Sprout *(WPE3GMW)*, Reading, Pa.
Doug Brede *(WPE3HAG)*, Pittsburgh, Pa.
Dan Ferguson *(WPE4AUL)*, Coral Gables, Fla.
Grady Ferguson *(WPE4BC)*, Charlotte, N. C.
Ray Bacon *(WPE5BFU)*, Baton Rouge, La.
Richard Allen *(WPE5BZO)*, APO, Wethersfield, England
Jimmy Davis *(WPE5EHL)*, Lawton, Okla.
Jerry Stuart *(WPE5EKT)*, Lawton, Okla.
Richard Harris *(WPE5FS)*, APO, Song Be, South Vietnam
Stewart Mac Kenzie *(WPE6AA)*, Huntington Beach, Calif.
Jim Young *(WPE6ENA)*, Wrightwood, Calif.
Trevor Clegg *(WPE6FAF)*, Santa Cruz, Calif.
Lin Robertson *(WPE6GVK)*, La Jolla, Calif.
Fr. John Pejza *(WPE6HCP)*, Ojai, Calif.
Dan Seibel *(WPE6HCU)*, San Leandro, Calif.
David Peters *(WPE6HDM)*, Modesto, Calif.
Henry Gac *(WPE8JST)*, Detroit, Mich.
Barry Woodyard *(WPE8JVP)*, Norwalk, Ohio
Bob Baumann *(WPE9IVZ)*, Batavia, Ill.
Jerry Barnes *(WPE9IZP)*, Madison, Ind.
Gary Bullinger *(WPE9JCZ)*, Aurora, Ill.
A. R. Niblack *(WPE9KM)*, Vincennes, Ind.
John Beaver, Sr. *(WPEØAE)*, Pueblo, Colo.
James Broden *(WPEØEIC)*, Denver, Colo.
John England *(WPEØETW)*, Pueblo, Colo.
Jack Perolo *(PY2PE1C)*, Sao Paulo, Brazil
Doug Renwick *(VE6PE4X)*, Oakville, Ont., Canada
Dean Frey *(VE6PE7N)*, Fort Saskatchewan, Alberta, Canada
Roland Wahlgren *(VE7PE1CR)*, N. Vancouver, B. C., Canada
Leo Alster, Rahway, N. J.
Ronald Budziack, Cicero, Ill.
Ronald Burris, Cincinnati, Ohio
Eric Earle, Maitland, Fla.
Joseph Hueter, Sr., Philadelphia, Pa.
Jeffrey Krenz, Bay City, Mich.
J. L. Metcalfe, Austin, Texas
Moiz Mutlu, Worcester, Mass.
Mike Russell, St. Louis, Mo.
David Schmidt, St. Joseph, Mo.
Thomas Wilson, Murrysville, Pa.
R. Sweden, Stockholm, Sweden
Sweden Calling DX'ers Bulletin, Stockholm, Sweden

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Mike Diekhoff (WPEØETY), Lincoln, Nebr.
Mike Hampton (WPE8JEZ), Birmingham, Mich.
Harry Okey, Jr. (WPE6ETT), La Jolla, Calif.
Craig Rice (WPE2OXR), Webster, N. Y.
Gerald Larocque (WPE1GED), Greenfield, Mass.
Robert Levin (WPEØFBN), Minneapolis, Minn.
Thomas Hart (WPE1EGH), Westwood, Mass.
James De Cava (WPE1GKM), Stratford, Conn.
Bill Corcoran (WPE9IUV), Chicago, Ill.
Mitchell Hyman (WPE2OPK), Brooklyn, N. Y.
Dave Lyon (WPE5ELS), El Paso, Texas
Ralph D'Canada (WPEØDCW), Florissant, Mo.
Bruce Nazarian (WPE8IAH), Detroit, Mich.
Gary McNelly (WPE9IRG), Cahokia, Ill.
Michael Northam (WPE7CME), Beaverton, Ore.
Mark Stevenson (WPE1GNI), Warwick, R. I.
Len & Don Boselovic (WPE3HEU), Pittsburgh, Pa.
Michael Owsian (WPE2OMW), Brooklyn, N. Y.
Mark Halliday (WPE3HKR), Doylestown, Pa.
David Hagerman (WPE2PWK), Delaware, N. J.
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Alan Harris (WPE8JQY), Oak Park, Mich.
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Eric Lebowitz (WPE2JJY), Jackson Heights, N. Y.
Barry Glaser (WPE2PUM), Brooklyn, N. Y.
Stanley Jones (WPE5EQR), Hollandale, Miss.
Ralph Newton (WPE5EQY), Fort Worth, Texas
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Robert Schramm (WPE9IZQ), Morton Grove, Ill.
Dan Broadbooks (WPE9IYK), Cottage Hills, Ill.
Ted Wozniak (WPE9INH), Chicago, Ill.
Douglas Meyer (WPE2OUS), New Rochelle, N. Y.
David Simon (WPE2PQP), Brooklyn, N. Y.
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Greg Garrett (WPE8JHX), Tallmadge, Ohio
Theodore Winkel (WPE9JAM), Madison, Ind.
Dave De Manigold (WPE8JUT), Detroit, Mich.
Patrick Griffith (WPE9HVW), Rockford, Ill.
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James Earl (WPE4HWP), Lynchburg, Va.
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Tom Hammer (WPE8JIC), Helena, Ohio
Thomas Wilk (WPE9IZV), Chicago, Ill.
George Fast (WPE8HMX), Red Bluff, Calif.

American music and frequent ID's with chimes—the city location is not yet known. Other recent loggings include YVQI, *R. Barcelona*, 3385 kHz, and YVKB, *R. Difusora*, Caracas, 4890 kHz, both noted in Spanish with Latin American music until 0400 s/off.

Vietnam (North)—*Voice of Vietnam*, Hanoi, is scheduled for 1000-1030, 1300-1330 and 1530-1600 in Eng. on 9760 and 11,760 kHz and for 2300-2330 on 9840 and 11,840 kHz. Reports go to No. 58 Quan-Su Street, Hanoi. This station is also being heard on 11,754 kHz in native language at 1435-1500 with some martial music.

Windward Islands—Windward Islands B/C Service, St. Georges, Grenada, is heard on 11,970 kHz to 0215 with an Eng. newscast at 0200. A new frequency in use is 15,180 kHz, to Europe at 1900-2000; this channel is dual to 15,105 kHz. —30—

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THE SIX SCOUT

(*Continued from page* 35)

of contacts on the relay used to switch the antenna from the transmitter to the receiver.

The front panel can be removed, the unused holes filled with epoxy, and the panel sprayed white—or any other pleasing color—as shown in the photo on page 33. Any commercial press-type will suffice to mark the various panel controls.

Checking It Out. To tune the transmitter, first insert an 8-MHz crystal in the holder. Then remove the power from the final amplifier by lifting the connection that supplies the B+ to the screen and plate (junction of *C10* and *RFC3* of original Globe Scout). Turn on the transmitter.

Now set the metering switch to indicate final grid current. With the four newly installed 32-pF variable capacitors (*C1*, *C2*, *C3*, and *C4*) about half-meshed, there will be a slight indication on the meter. Start at *C1* and adjust the four capacitors progressively for a maximum meter indication. Repeat until there is no further increase in the reading. The meter should indicate between 4 and 6 mA.

If the components were installed properly, and tune-up done correctly, the signal at the output of the crystal oscillator (*6V6*) should be triple the crystal frequency, while the output of the newly installed 5763 will be about 50 MHz. Tune-up can be refined by following instructions given in *The Radio Amateur's Handbook*.

The *Handbook* also describes exacting adjustment of a neutralizing capacitor. However, if you set this capacitor (*C10*) near minimum, you will not be far off.

Turn off the power to the transmitter and reconnect the B+ to the final amplifier. Then connect the antenna output to a dummy load—a 40-watt light bulb will suffice. Turn on the transmitter and, with the meter indicating final plate current, adjust capacitor *C11* for a current dip, then *C12* for an indication of about 100 mA.

Final output tuning can be done with the transmitter feeding the antenna. —30—

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